Applied Ergonomics

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Lecture - 05

Welcome to you all once again. So, we were covering this physical ergonomic part. So, this lecture is in continuation with the previous lecture. So, in the previously, we have covered the introduction to physiology.

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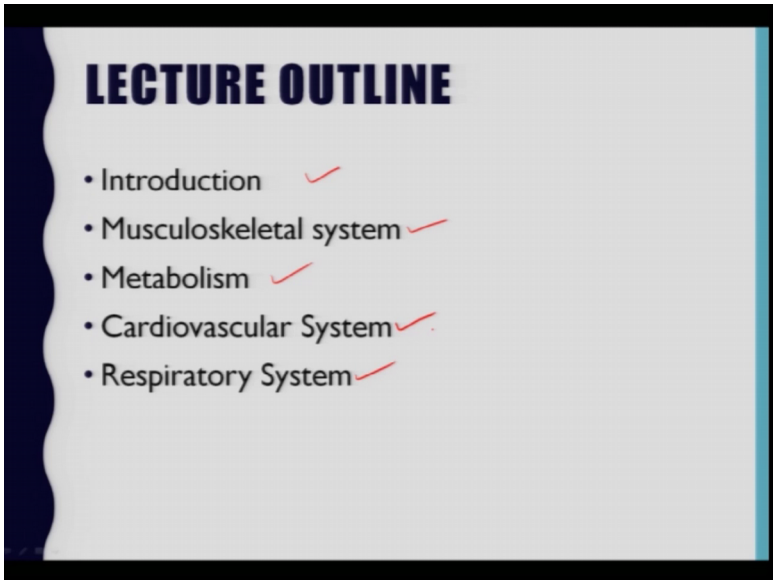

So, musculoskeletal system, we have covered and some basics to metabolism we have covered. So, now, in this lecture, we will be covering the cardiovascular system and respiratory system

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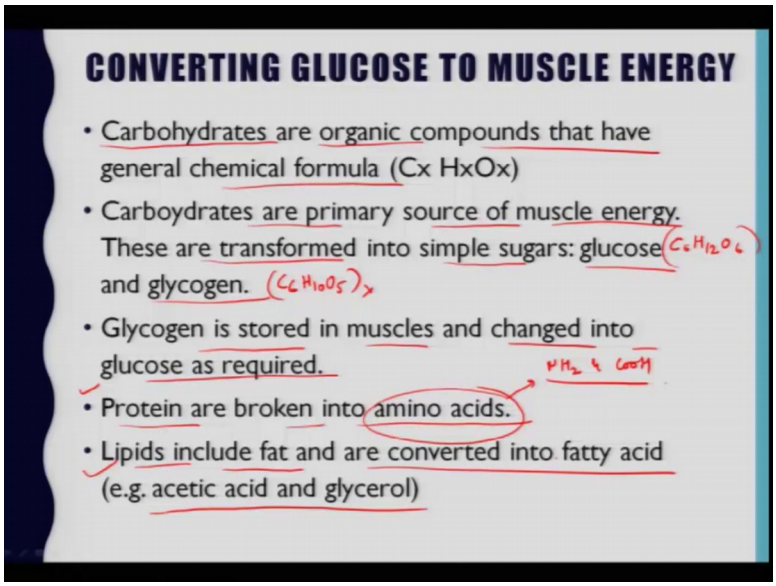

So, in the previous lecture we have talked about various nutrients. Basically there are three basic nutrients, which required for the body and related energy content, and possible functions, we have discussed in the previous lecture. So, those are carbohydrates, lipids and proteins. So, in series with it, with that we have also described about the carbohydrates, which are the organic compounds that have general chemical formula of a C x H x O x, and basically this carbohydrates are the primary source of muscle energy

These are transformed into simple sugars. So, glucose and glycogen. So, the chemical formula plus this glucose is C 6 H 12 O 6, and for glycogen this formula goes to C 6 H 10 O 5 molecule. So, this glycogen is stored in the muscles and chased into a glucose as required, and the another kind of nutrients required for the body is protein. So, that protein is broken down amino acids. So, this amino acid is nothing but an organic compound which consist of amino group and carboxylic group. So, it consist of amino group and carboxylic group, and another kind of nutrient is lipid include fat, and converted into fatty acids. Those fatty acids are acetic acid and glycerol.

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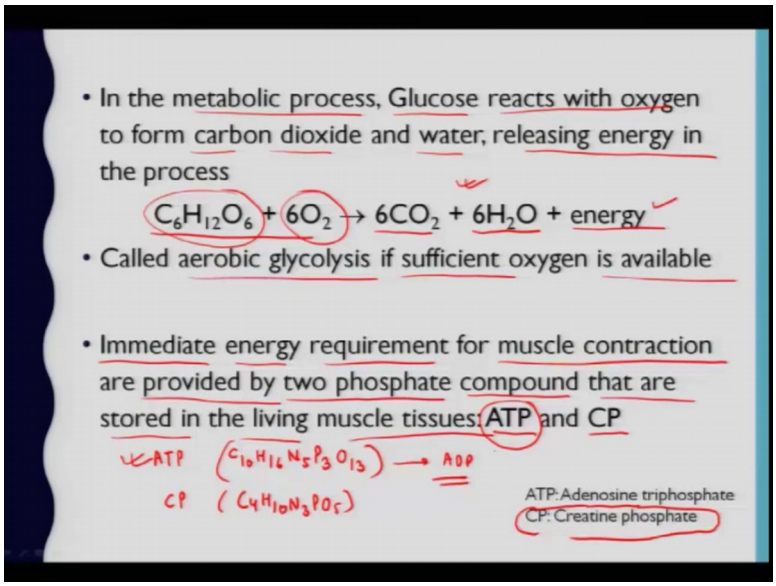

So, here we discussed that in the metabolic process, the glucose reacts with oxygen to form carbon dioxide and water releasing energy in the process. So, the chemical reaction that occurs, is the molecule of the glucose, reacts with the oxygen, it gives the, as a react, as a product, as a carbon dioxide and some molecules of water plus some sort of energy. This particular energy is liberated, because of this reaction

So, this particular reaction is known as aerobic glycolysis, if sufficient oxygen is available, and basically for the body immediate energy requirement for any activity. Let us say muscle contractions are provided by two phosphate compound, that are stored in the living muscle tissues/ those tissues are A T P and C P. In that A T P stands for adenosine triphosphate, whose molecular formula is C 10 H 16 N 5 P 3 O 13.

So, this is the chemical formula for A T P. A T P is adenosine triphosphate, and another the kind of tissue is muscle tissue is C P. So, this C P stands for creatine phosphate, its chemical formula is C 4 H 10 N 3 P O 5. So, in the case of A T P energy is made available to the cell by hydrolysis, in which one of the triphosphate bonds is broken to form A D P. So, this A D P is adenosine diphosphate. So, the kind of reaction that takes place, which I am writing here as an A T P plus H 2 O, that will give the body

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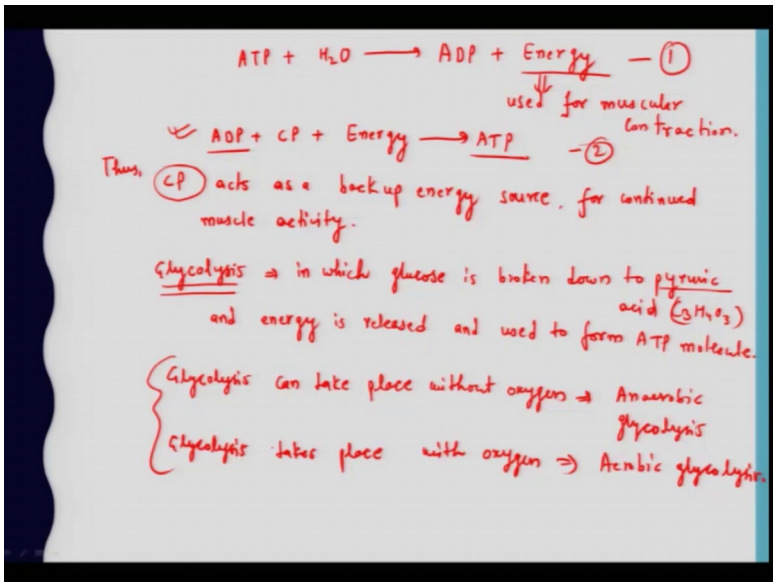

So, A D P plus energy; this is the energy used for muscle contraction, this particular energy used for in fact, muscular contraction. So, in order to, for the muscle cells to continue to be supplied with energy, this A D P must be converted back to A T P. So, this is accomplished by three possible mechanisms; one of which involves the C P; that is creatine phosphate in the cell, according to the forming reaction, that I am writing here. So, A D P plus C P plus energy gives you A T P.

So, it is a completely reversible process. So, thus C P acts as A. We can say that as a backup energy source by reacting with A D P to replenish the supply of A T P for continued muscle activity. So, if we could name it as a equation 1 and equation 2. So, the use of C P in this reaction number 2 is the fastest way to produce A T P. However, the energy generated capacity of C P is very limited.

So, for sustain muscular activity, the attenuate way of producing A T P must be used. So, these alternative involvement, involve reactions known as the glycolysis. So, this glycolysis is the process, in which glucose is broken down to one. Another molecule is known as pyruvic acid, whose molecular formula is C 3 H 4 O 3, and energy is released and used to form A T P molecule. If sufficient amount of oxygen are available, then this pyruvic acid is oxidized to form carbon dioxide and water. However, the glycolysis can also take place without oxygen. In this case it is known as anaerobic.

But the products of the reactions are different from those, and those in the presence of oxygen. So, if it is in presence of oxygen, with oxygen it is known as, so glycolysis, which takes place with oxygen, then it is known as aerobic glycolysis. So, there are basically two important differences, in these terms of, in these forms of glycolysis, is that.

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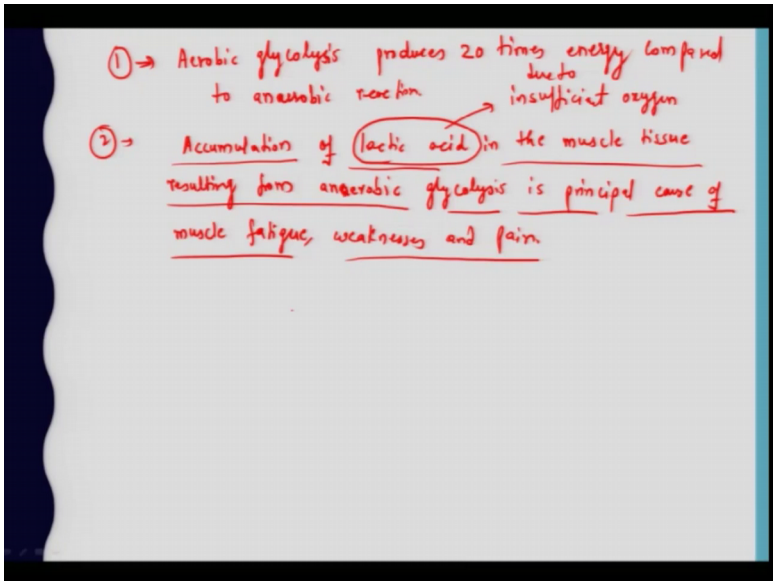

The first kind of difference which we can find out in the book, as well that this aerobic glycolysis produces about 20 times the energy compared to an aerobic reactions.

This energy is then used to increase the amount of A T P and creatine phosphate, available for continued muscle activity. The second point is accumulation of lactic acids in the muscle tissue, resulting from an aerobic glucose. Glucolysis is principle cause of muscle fatigue weaknesses and pains. So, why this lactic acid is coming into picture that if insufficient oxygen is provided, then the this pyruvic acid is converted to lactic acid

So, the presence of oxygen in the body is important, because this particular lactic acid is produced, because of the insufficient, due to insufficient oxygen provided. So, basically the accumulation of lactic acid in the muscle tissue resulting from the anaerobic glycolysis is principle cause of muscle fatigue, weaknesses and pain. So, these conditions ultimately limit the amount of activity that a muscle can continue to perform.

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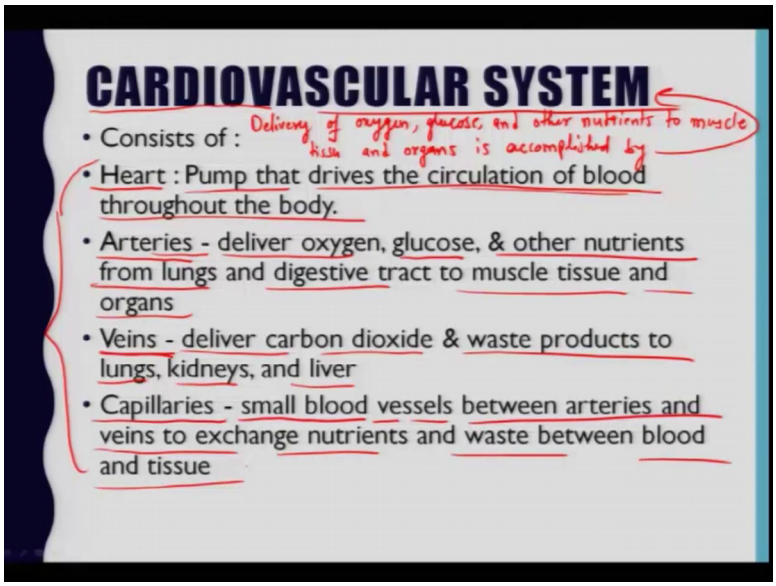

So, now we will go to the next topic; that is cardiovascular system. So, in that, these topics are understanding of the functioning of this topic, and various parts of the bodies, very important in order to aware, make yourself aware of the ergonomical factors, because if you are not physically fit, you cannot contribute to the system design or product design or any, you cannot be as an, you cannot perform work as a ergonomist, because it is very much essential that you should know the physical aspects, cognitive aspects and other aspects; like the knowledge related to physical work involvement in which you are working.

So, that knowledge is very much important for an ergonomic learner. So, in the, as a next topic we will try to understand the basic function of cardiovascular and respiratory systems, which are essential part of our body, and that directly affects the performance in terms of physical effort is concerned. So, in that cardiovascular, our discussion related to the metabolism and glycolysis indicates that delivery of oxygen is very much important. And in fact, the key factor in the efficient liberation of energy from glucose for any kind of muscle activity.

So, this oxygen is basically captured from the air by our respiratory system. So, I am repeating this sentence once again, that oxygen is, basically oxygen is captured from the air by our respiratory system. So, presence of oxygen is very much important as far as our metabolism is concerned, and other body part functioning is concerned. So, this

particular respiratory system consists of many parts that I am going to describe in detail. So, here the oxygen, importance of oxygen we have understood. So, the delivery of oxygen and glucose and other nutrients to a muscle cells and organs is accomplished by the cardiovascular system.

So, a model of these two systems I am going to illustrate in next slides, before that we need to learn that; what are the basic components of the cardiovascular system. So, in that cardiovascular system, delivery of oxygen, basically delivery of oxygen glucose and other nutrients to muscle tissue and organs is accomplished by cardiovascular system. So, about primary, and this particular cardiovascular system consist of heart, arteries, veins, capillaries.

So, it is very interesting to know that the functioning of these sub parts, these parts which has a hole, build the hole cardiovascular system. So, in that the function of heart is the pump that drives the circulation of blood throughout the body. The function of artery, it delivers oxygen glucose and other nutrients from lungs and digestive tract to muscle tissue, and organs. Rule of veins is, it delivers carbon dioxide and waste products to lungs, kidneys and liver capillaries. These are the small blood vessels between arteries and veins to exchange nutrients and waste between blood and tissue.

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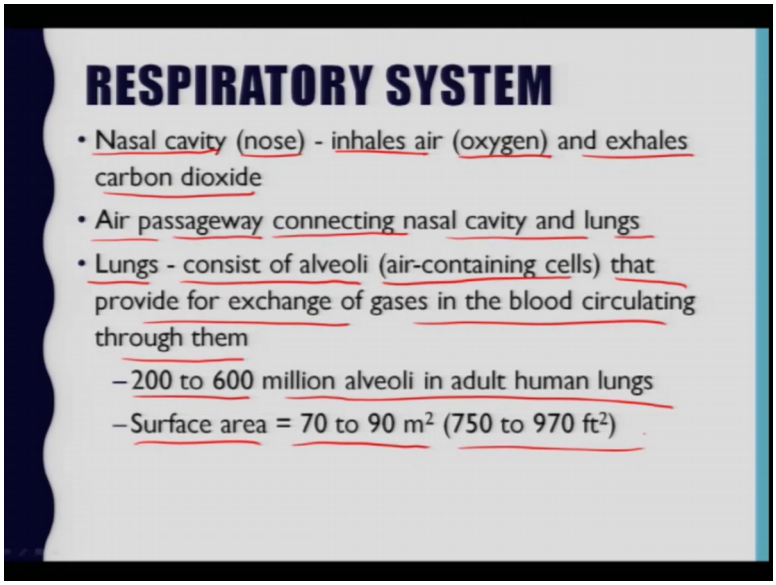

So, another component is, nasal activity; that is nose, it inhales air that is oxygen and exhales carbon dioxide, air passageway connecting nasal cavity and lungs. Lungs, its

consist of alveoli; that is air containing cells that provide for exchange of gases in the blood circulating through them. So, it is 200 to 600 million alveoli in the adult human lungs, and its surface area is 70 to 90 meter square; that is around 750 to 970 feet square.

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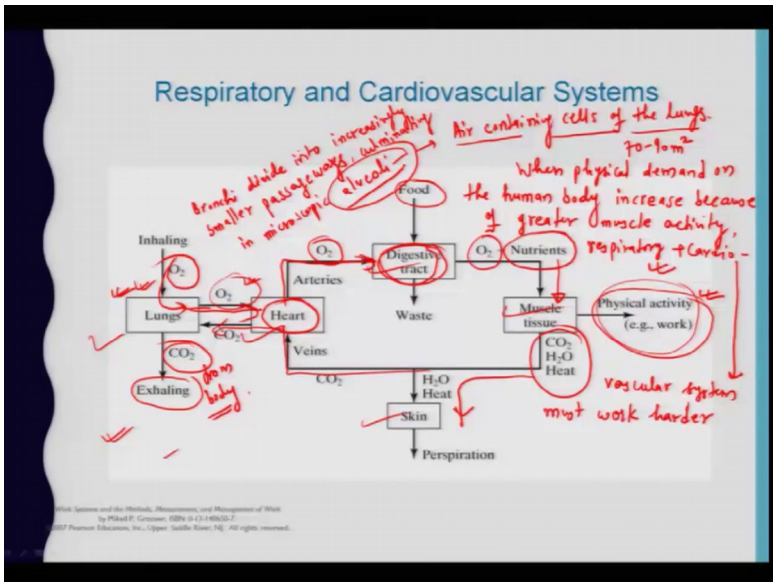

So, this taken from the M P Grover book; so this I found, it is most interesting and most important schematic, which is showing that the major component of respiratory and cardiovascular systems, and how they work together to transport material necessary for metabolism. So, in that we have to, since the basic components we have covered, and they are functioning. Now we have to learn the, what are the placement of particular component, and what are the energy sources, and the step by step procedure through which that particular physical activity is performed by our body.

So, as you can see from this figure, these lungs are of very much important, and of particular interest in metabolism, because they are the source of oxygen used by the muscle cells. So, they also exhaust this carbon dioxide from the body, these particular lungs. Basically lungs are the primary component of human respiratory system, which includes nasal cavity and air passage way between it and lungs. The passage way extends from the neck into chest where it connects to the right and left main bronchi leading into the lungs.

This is bronchi divide and subdivides into increasingly smaller passage way, culminating in microscopic alveoli, which are the air containing cells of the lungs. So, alveoli is the

air containing cells of the lungs. So, although small they are huge in quantity inside our body. So, these are above 200 to 600 million, and providing 70 to about 90 meter square area; in fact, of the surface area in an adult human for oxygen and carbon dioxide exchange.

Apart from that, the oxygen content in the air, oxygen content in the air inhaled into the lungs and is diffused into the blood, which basically being, which flows back to the heart and this connected lung, and heart is connected with the passage of oxygen, and oxygen, this inhaled into the lungs is diffused into the blood, and flows back to the heart, and its pumped throughout the body by heart.

So, basically this through arteries, this oxygen goes to the digestive track, and this oxygen helps in the digestive tract in digestion of the food, as well and in the digestive tract. It has converted to oxygen and suitable nutrients required for our body, which goes to the muscle tissue; that is helping in the physical activity, which we perform on the daily basis. So, as a waste product these muscle tissues are liberating this carbon dioxide heat and water. So, that water in the form of perspiration is going outside the body via skin.

So, again that carbon dioxide is also going to the vein, via vein to the heart, and this carbon dioxide from heart goes to the lung, and a lung again exhales this carbon dioxide from the body. So, this is an nutshell the whole respiratory and cardiovascular system components and their functioning which we need to understand, because these are our body parts, and we need to have a proper knowledge or understanding of the various functions in order to live longer.

So, this is all about in a nutshell, the functioning and of the various component of this coupled system. Since we are more concerned with the physical activities; so what happens exactly, when the demand of the physical effort arises? So, when this physical demand, when physical demand on the human body, physical demand on the human body increase, because of the muscle activity, the respiratory system and cardiovascular system must work harder.

So, the body must respiratory plus cardiovascular system must work harder. So, when the greater physical demand is there. So, it gives pressure to each and every component of

this coupled system. So, lungs, heart, digestive tract muscle tissues, and as well as a skin both are get, all get influenced. So, the body must breathe heavier.

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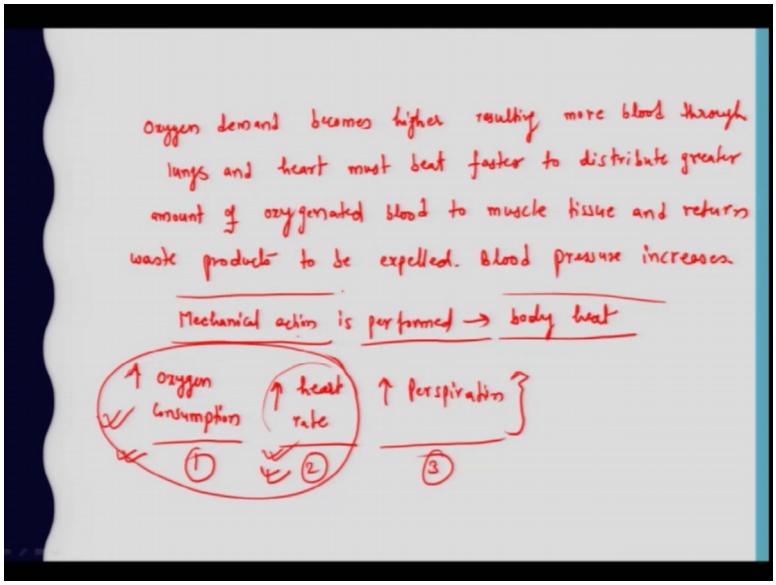

When physical demand increases and as well as the oxygen requirement becomes higher, when physical demand, oxygen demand becomes higher resulting more blood, more bloods. Basically more blood through lungs and heart must beat faster to distribute greater amount of oxygenated blood to muscle tissue, and return waste product to be expelled.

Blood pressure increases in this condition, and proportionality more blood is distributed to the muscles, when they are engaged in moderate, in moderate to heavy physical activities. So, in addition to this mechanical action accomplished by muscles, body heat is produced. So, when mechanical action is performed, it is resulted into the production of heat within the body.

So, the process of converting this chemical energy contained in the nutrients into the mechanical energy, manifested in muscle activity is far from 100 percent efficient, and the body perspires to dispread the excess heat produced by the increased muscle activity. So, in a nutshell, we can say that greater, thus greater oxygen consumption faster will be heart rate, and then increase in the perspiration process.

So, these are the three principle reactions of the human body, when we increase physical efforts or physical activities. So, first kind of reaction is oxygen consumption, more and more oxygen consumption will be there. If we increase the physical efforts, heart rate will be increased. Second and third is perspiration as a waste product. So, oxygen consumption and heart rate; so this oxygen consumption and heart rate can be measured, while a person is working, and are frequently used in ergonomics to access the level of stain on the human body, due to physical or mental reaction or exertion.

So, in this way, the next aim will be to calculate, and to understand about the oxygen consumption and heart rate. These two aspects, we mostly used to calculate in order to have some data, or interpretation in ergonomic research. So, in the next lecture, we will be explaining the energy expenditure rate, and what is its relation with the oxygen consumption, and its increase in rate when the physical demand goes on increasing for the body, and in this way we right now we close this particular lecture, and just for the fact.

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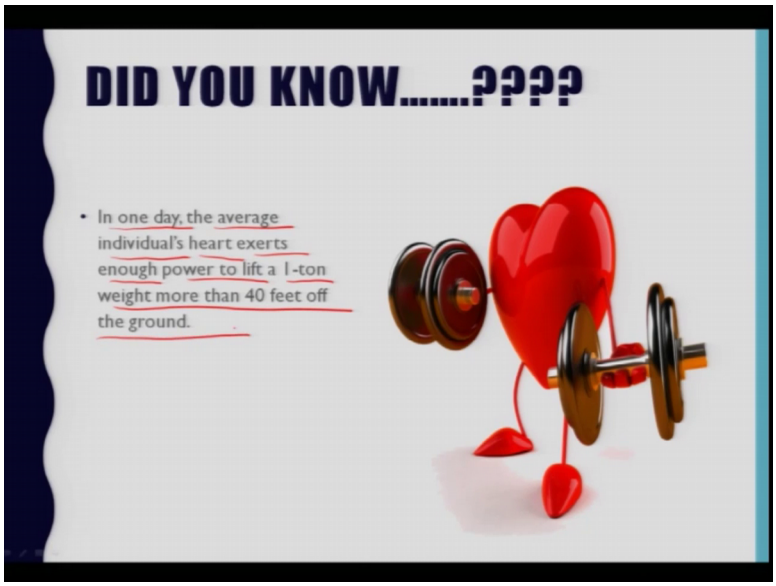

Did you know that in one day, the average individual heart exerts enough power to lift a 1 ton weight more than 40 feet off the ground.

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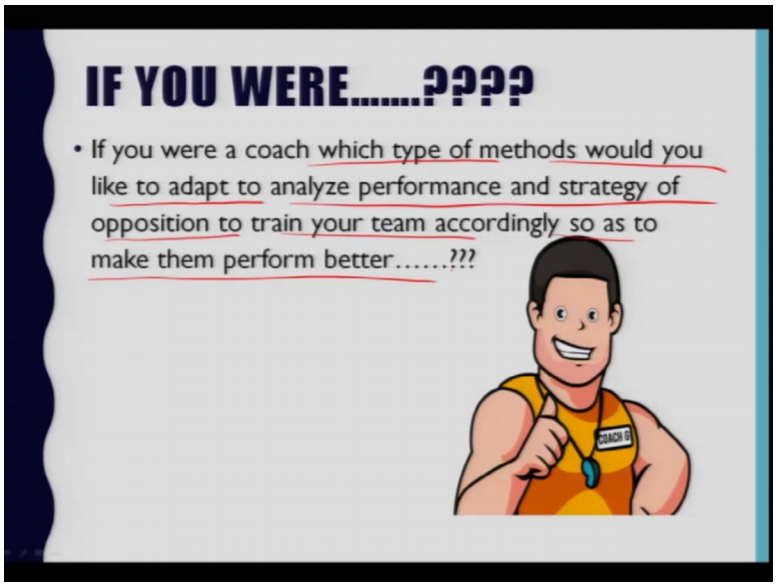

If you were a coach, which type of methods would you like to adapt to analyze performance and strategy of opposition to train your team accordingly. So, as to make them perform better, so that is a, this is a ergonomic coach, and you have to sink an analyze over those sentences, just have a brief history of human physiology.

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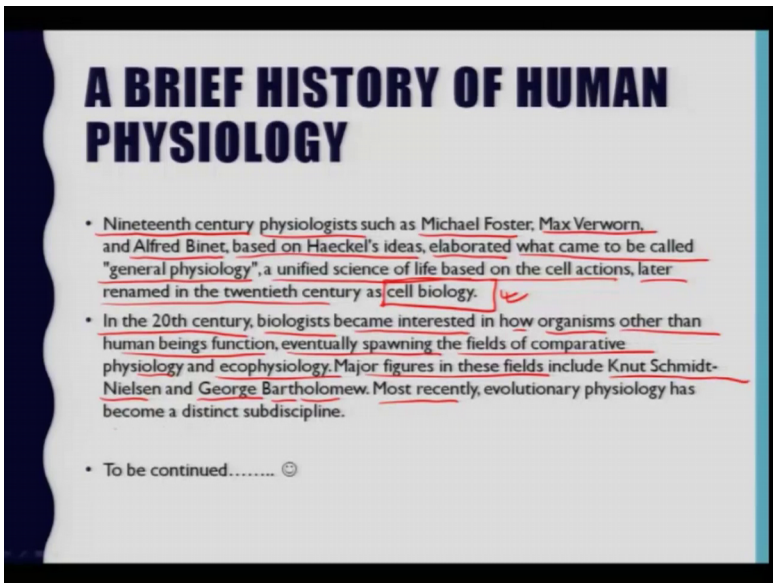

Since we are dealing with physiology; so there is a very much interesting fact that in 19th century physiologist such as Micheal Foster, Max Verworn and Alfred Binet based on the Haeckel's ideas, elaborated what came to be called general physiology, a unified

science of life, based on the cell actions, later renamed in the 12th century as cell biology.

So, I hope you are relating all the knowledge that we are sharing here with, how much importance that particular ergonomic course is, and in our life. So, in the 12th century, biologist became interested in how organisms other than human beings function, eventually spawning the field of comparative physiology and ecophysiology. So, major figures in these fields are include Knut Schmidt Nielsen, George Bartholomew. Most recently evolutionary physiology has become a distinct subdiscipline.

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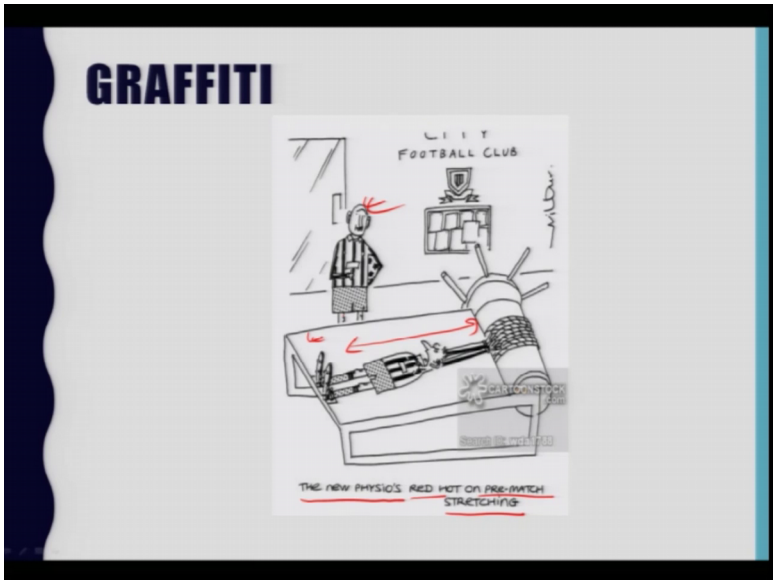

So, with this there is a one more graffiti for you in a football club, as you can see that coach, the new physios red hot on a pre match stretching. So, this kind of stretching, this particular physio has giving to the player.

So, that is all for now.

Thank you.