Animal Physiology
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Lecture - 03
Homeostasis & system integration

Welcome back to the third lecture in the animal physiology series. So, in the last class we talked about the organization, we talked about the different classification of anatomy; the gross anatomy, the microscopic anatomy, in terms of cytology in terms of astrology then we talked about the physiology at different level at the cellular level if you remember the pyramid what we meet the chemical level, cellular tissue level, organ level, system level and the organismic level.

Now, when we talk about a system every system every living system is calibrated to function at certain optimal physical parameter; what does that mean? Let us take a example of human body where most of the reaction or almost all the reaction takes place in a aqueous medium; in other word in a medium of water most of the reaction takes place at a temperature regime of 25 to 35 degree centigrade, body maintains optimal temperature in and around that range. We can withstand a certain amount of pressure beyond that we are having problem we are adapted to live at a specific oxygen tension as well as at a Co2 tension beyond that we will be having trouble.

So, in other word, the dynamic systems are tuned or fine tuned to function within a narrow or slightly broad window of physical parameters now if there is a change in those physical parameters what do I mean by that see for example, your body is adapted to withstand say thirty degree centigrade fine. So, suppose your body function. So, if the temperature of the surrounding rises to say 45 degree. So, automatically the outside temperature is very high. So, automatically your body will absorbs a lot of heat. So, from thirty degree optimal temperature it will go up. So, in that situation body has to re calibrate itself this is one example.

Or say for example, your body is adapted to live a at a specific oxygen tension and suppose you are claiming mountains as you are claiming higher and higher and as the atmosphere is getting rarer and rarer the oxygen tension reduces at a higher fortitude there is lack of oxygen. So, automatically because the lack of oxygen you will be

inhaling lesser oxygen. So, under that situation your body will have to recalibrate itself in order to ensure or compensate for that lack of oxygen which is not available because you are at different ecological needs.

Similarly, if you go down the ocean down you are doing scuba diving or something else something of that sort where there is no oxygen and the pressure is high how you adopt to that high that hyperbaric or hypobaric pressures. So, all these situations we will point to one aspect that body has a mechanism by virtue of which it can recalibrate itself and the process which is involved in it is called homeostasis.

So, today we will talk about how the body maintains its homeostasis what is the basic feature what are the basic component which helps in maintaining the homeostasis what are the different kind of feedbacks systems which are involved in it. Mostly there are 2 feedback systems negative feedback loop and positive feedback loop and apart from it we will talk about some of the examples of negative feedback and positive feedback.

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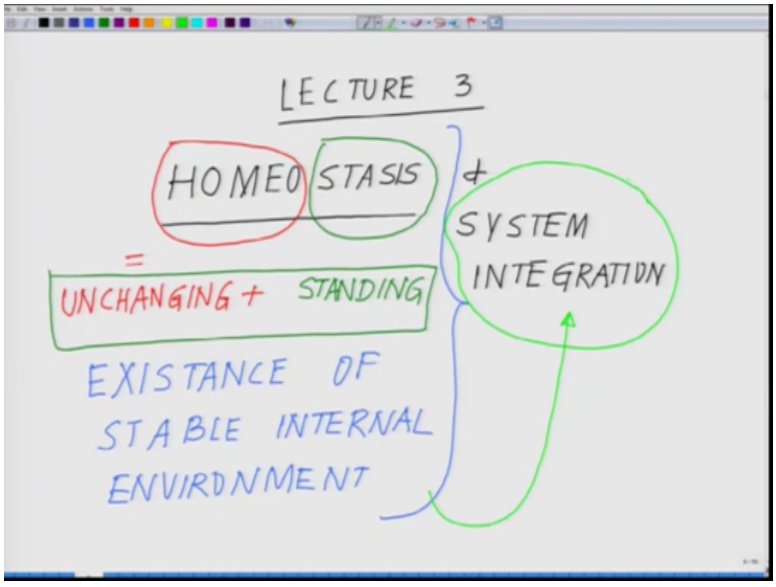

So, let us start the class with which is our third lecture; lecture 3 and the topic what will be dealing today is homeostasis and system integration homeostasis and system integration what this word homeostasis means if you break this word into 2 parts say for example, you said homeo as the one word and stasis as the second word. So, homeo means unchanging; unchanging which is not changing plus stasis means standing. So, the body maintains its status or re-calibrates it and this whole process is called homeostasis.

So, in other word in a simple language if you put it; that means, existence of the stable internal environment existence of stable internal environment internal environment this is what is meant by homeostasis and a homeostasis is the one which leads to what we call as system integration a system gets integrated because a system can recalibrate itself by different mechanism in order to allow it to function.

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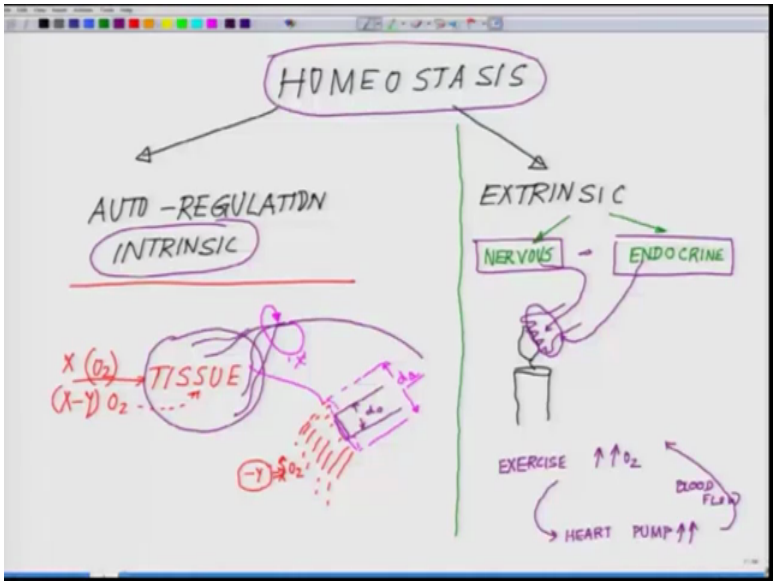

So, now from here where let us move on to the next slide where we will talk about what are the different mechanisms of homeostasis. So, homeostasis could be classified into 2 parts one is the auto regulation or intrinsic auto regulation or intrinsic homeostasis and the second one is extrinsic homeostasis and example of such things say for example, if it is auto regulation or a intrinsic say for example, we have tissue and this tissue is say for example, this is used to with a particular concentration of oxygen x concentration. So, now, x minus y concentration of oxygen now this tissue is receiving. So, it means here is this minus y reduction in the optimal concentration say for example, I said five unit oxygen is needed per minute now you are getting 3 minute of oxygen per minute it means there is a deposit of 2 unit of a oxygen which is there what this tissue will do.

Now, in this situation what this tissue will do is here are blood vessels which are bringing the oxygen to this tissue and will come later into that how these are designed and everything. So, what it will do these blood vessels which are present there sensing that there is a lack of oxygen here they will secret certain things all by themselves by sensing

lack of oxygen or x factor this factor x will change the diameter of the blood vessels originally the diameter of the blood vessel is like this if this is the d the original diameter d o which is the original diameter post secretion the diameter will become like this which is the new diameter d altered d a.

Now, what will happen the amount of blood which will be supplied to this tissue will be more and this more blood which is being supplied to the tissue will compensate for that minus y amount of oxygen which is the deficit amount will be compensated by this dilated vessel and the blood supplied through that dilator vessel. So, this is an example of auto regulation on maintaining the homeostasis.

Now, what about the other one when we talk about the second example which is extrinsic situation extrinsic is a situation which is controlled another control of mostly not always true, but just for your initial understanding sake is another control of the nervous or the endocrine system see for example, there is a flame. So, for example, there is a flame here and by mistake you put your hand there. So, automatically there will be a burning sensation. So, immediately what it will do a nervous system will govern the mussels here to immediately remove it contract and will try to localize the effect in that region it will not happen that if you do. So, that all over your body you will have the burning sensation. So, it will confine that burning sensation at that specific location. So, this is governed by a nervous system or the endocrine system or sometime by both of them.

So, this is one example of it similarly when you are doing exercise another example let us talk about it when you are doing exercise. So, when you are doing exercise your consuming more oxygen. So, for example, lets write it down you are doing exercise you are consuming more oxygen and if you are consuming more oxygen this will tell the heart to pump heart pump pumping will become more and the heart pumping is more automatically there will be more blood flow which will compensate for the lack of oxygen. So, in other word these are the process by virtue of which a system is broad band to its original state and that is what we meant by homeostasis.

Bringing back to its original state or trying to maintain it status go where it was. So, now, from here what we will do. So, I am giving to you example the auto regulation or intrinsic process and the extrinsic process where the nervous system and the endocrine system is controlling it.

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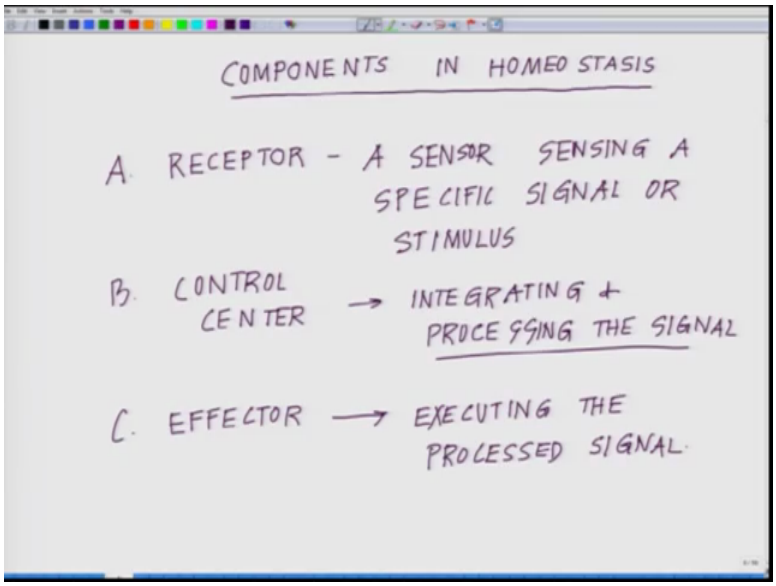

Next we will talk about what are the components which are bringing about this homeostasis component of homeostasis let us talk about those components in homeostasis.

So, the component in homeostasis are you first off all needed a sector first thing we needed a receptor which acts as a sensor we will come to that then you need a control center third important thing you needed a effector which will take care of it and will give the examples of each one of these 3 situations. So, your receptor is basically a sensor sensing a specific signal or stimulus sensor sensing a specific signal or stimulus your control center is doing the work of integrating this signal integrating and processing the signal and your effector is executing the processed signal. So, these are the 3 component.

So, before we proceed further I will give you an example from our day today life say for example, I am standing in this room at this point if I see the air conditioner board it will panel show that this room at as we maintain at a temperature of say to any 4 or 25 degree centigrade it is here air conditioner room where I am standing. So, now, what will happen if the temperature of the room all of a sudden goes up suppose there is a wend pipe from a lot of heat starts coming inside the room a lot of hot air is grown inside the room. So, the room temperature thermo stasis set of the air conditioner is saying that it has a 23 degree centigrade.

So, if the temperature of the room goes up from the 23 degree centigrade. So, automatically there will be a thermo meter which will sense it and once this thermo meter senses it, it will tell the thermostat or the effector mechanism that there is increasing temperature then what this will do this will tell the effector which is the air conditioner to get operated and bring back the temperature from what is over it rises from 23 degree centigrade and it will bring it back to 23 where the 23 or 26 where the temperature of the room has been set.

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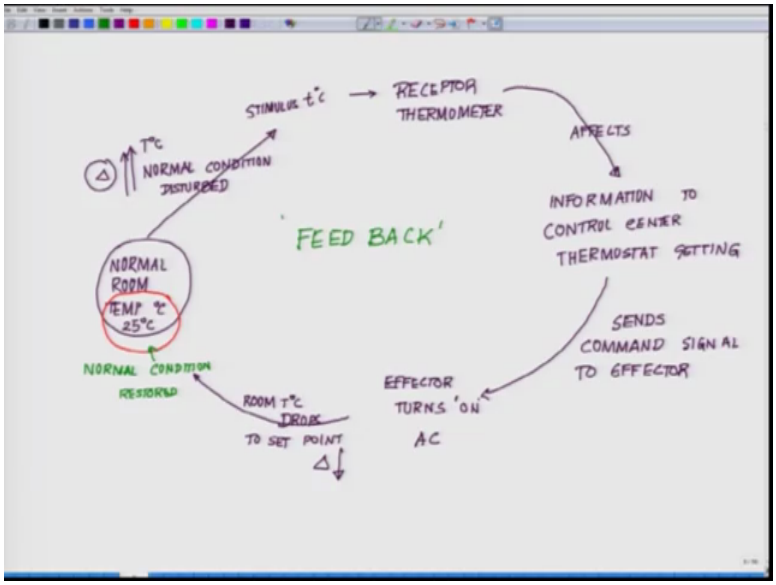

So, this is in a way we can call it, it is a feedback system let me draw it that will make more essence to people it is a example out here I have a normal room temperature normal room temperature say I would like say like 25 degree centigrade now for somewhere other normal condition is disturbed normal condition disturbed the normal condition is disturbed. So, there will be a stimulus and there is an normal condition disturbing in other word there is an say for example, there is an increasing temperature.

So, what will happen this; this temperature will be monitored by. So, in the form of receptor in this case there receptor will be a in aliment object which is a thermometer. So, thermometer senses that there is an increasing temperature of this room what this will do this effect there is an increasing temperature will be transmitted information to the control center or thermostat setting info information to control center or which is also the thermostat setting thermostat setting.

What the thermostat setting knows it its sends a command signal from here a command signal is will be relayed by the thermostat send sends command signal to effector and this effector then turns on the air conditioner see here air conditioner is on now that increase temperature whatever that delta increase what has been happened here. So, that delta increase will be brought down out here. So, the room temperature drops to set point and in this case your set point is 25 degree centigrade it will brought and this will eventually normal condition will be restored which is again 25 degree centigrade normal condition restored.

So, this is the kind of feedback role what we use in any kind of engineered systems and these feedbacks are all inspired from biological systems biological system exactly follows these kind of feedback think of a situation before I explain in terms of what happens.

So, for example, you are running after running all of us sees like you are a perpetration lot there is all your shirts and everything kind of get wet there is huge amount perspiration happening why is it. So, what is the reason that when you are run after that lot of heavy exercise and there is a huge amount of perspiration lot of sweat and everything. So, there is a feedback mechanism which is helping you.

So, let us dissect all physiology have to understand it is all about dissecting the situation what possibly is happening in your body as long as you have that analytical ability to break the problem into small wet some pieces physiology will be a cake walk. So, you have to have a very strong analytical bend to break a problem and that is something will cultivate over years after years through your studies through real life situation a good doctor is the person who can analyze he or she listens to the patients and based on that the analytically break down the problem possibly this and based on that they prescribe medicine prescribe test or make the diagnostic whatever they feel.

Now, let us break this problem what just now I told you lets go to the next page and try to you know dissect out the system what is happening.

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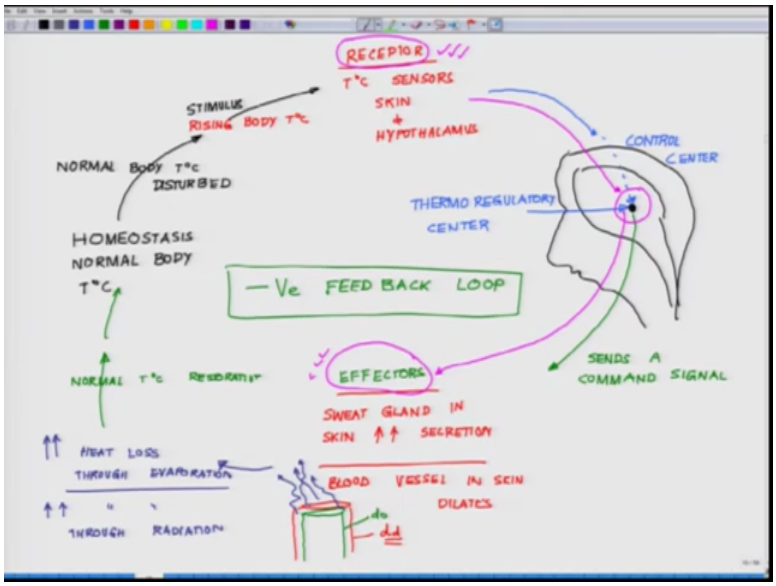

Now,. So, simple example let us see now we talked about the normal outside the system now will talk about homeostasis in a biological system homeostasis where normal body temperature t degree centigrade. So, now, this normal is disturbed out here say for example, normal body temperature disturbed it could be any reason now let us assume that your running normal body t degree centigrade disturbed.

So, your stimulus here is rising body temperature you are running stimulus is rising body temperature this is stimulus will be sensed by certain receptors and these receptors are present on your skins as well as in hypothalamus I will tell you what is hypothalamus. So, these temperature T degree centigrade sensors are present on your skin and hypothalamus. So, where is hypothalamus? So, hypothalamus is a region of the brain pretty deep inside this is the part of my brain pretty deep inside you like you know draw 2 pins some from here someone in the centre there is the small organelle which is called hypothalamus which is newer in the crime system that is the temperature controller

So, not only my skins are sensing that there is a increasing temperature there is hypothalamus which also sense there is a increase in the temperature once this happens what will happen. So, this info or this information there is an increases in temperature goes to the different control centers. So, here is the control center what we are talking about. So, I told you where is hypothalamus; hypothalamus is. So, this is the brain is which going and hypothalamus is sitting somewhere out here somewhere just out here.

So, this info is reaching the hypothalamus which is essentially is that control enter control center and this is the thermo regulator center this is also called a thermo regulatory center.

Now, at the thermo regulatory center this hypothalamus sends a command signal sends a commands this command signal reaches the effectors. So, I told you there will be receptor there will be control center and who are the effectors here, now let us enumerate the effectors who are involved in this game effectors are sweat gland which sweat gland in skin increases the upward arrow are showing increases the secretion of sweats that is why use sweat a lot. And second thing what happens is blood vessels in the skin dilates blood vessel in skin dilates was these 2 things happens dilation means there is a increase in the diameter of the blood vessels just suppose if this is the original diameter in the green this is d o and this red color is showing d, d dilated diameter and based on this, this leads to 2 things happens after this post sweat gland in a skin increases specious and response and it leads to there is a increased heat loss from the body because our body temperature is high increase heat loss through evaporation because your sweating a lot as well as your blood vessels have dilated.

So, your evaporation surface area has gone up and second there is a increased heat loss through radiation again that is because you have a more surface area and this eventually leads to what we called as normal temperature restoration and this whole mechanism is a negative feedback loop.

So, this is how a negative feedback loop helps in maintaining the homeostasis in temperature is it clear to you guys think over it whenever you sweat whenever many such. So, you see what we try to do we break the whole one thing that the body temperature rises because of exercise and we started sweating. And then we build the whole story and this is exactly what I expect from you people from this moment onward as one as you listen to this lecture is you start dissecting think what are possible could have happened is the temperature rises what will happen if the pressure rises, what will happen if the pressure falls what will happen or if there is too much light, what will happen if there is too much heat what will happen.

So, these are the parameters what you have to do and then based on that there are several levels of in like you know complication you know receptor the molecular structure of the

receptor the cellular structure of the receptor there is. So, many levels the organismic level what is the receptor size within the control center how this circuit is functioning how this is getting transmitted what is the mechanism of transport how from this center the effector is been connected what is the structure of the effector at the cellular level at the molecular level and so on and so forth and how this whole system is integrated into one loop.

So, this is one example of negative feedback in a next class what we will do we will talk about the positive feedback just the reverse of it feed forward and we will talk about the frame of reference of studying anatomy and physiology.

Thank you.