Basics of Biology
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Lecture 46
Homeostasis (Part 1)

Hello, everyone. This is Dr. Vishal Trivedi from Department of Biosciences and Bioengineering, IIT, Guwahati. And what we were discussing, we were discussing about the properties of the living organisms. And in this context So, far what we have discussed, we have discussed about the origin of life, we have discussed about the classifications of the living organisms, we have discussed about the evolutions.

And that has given us the understanding how the different organisms are being evolved onto the earth. And then subsequent to that, we have also discussed about the different types of cells whether they, it is the prokaryotic cell or the eukaryotic cell. And not only the cellular structures, we have also discussed about the structure and functions of the different organelles, what are present into the eukaryotic cell.

So, we have discussed about the chloroplast, mitochondria, endoplasmic reticulum, nucleus, cytosol and many other organelles and what are present in the cells. And then we have also discussed about their functions. Subsequent to that we have also discussed about the biomolecules. So, these biomolecules are contributing into the different types of functions within the cell, and many of these biomolecules are important for the structure and the function of the different organelles.

So, we have also discussed about how the these different types of biomolecules are contributing into the structure and function of the different types of cells. And since these biomolecules are also regulating the different types of cellular processes, we have also discussed about the different types of cellular processes, whether it is the central dogma of life where we have discussed about the replications, transcription and translations. or whether it is related to the some of the crucial immune responses what we have discussed.

So, we have discussed about how the antibodies are being generated, how we have, how we can actually be having the better defense response against the infectious organisms

and So, on. And then we have also discussed about the vesicular trafficking. Subsequent to that we have also discussed about the physiology of the living organisms.

So, in that context, we have discussed about the human physiology and within the human physiology we have discussed about the digestion, circulatory system, nervous system and muscular systems. So, why we are discussing all this, why we are discussing about the different properties of the living organisms and what is the basic need of a living organisms to continue its life cycle

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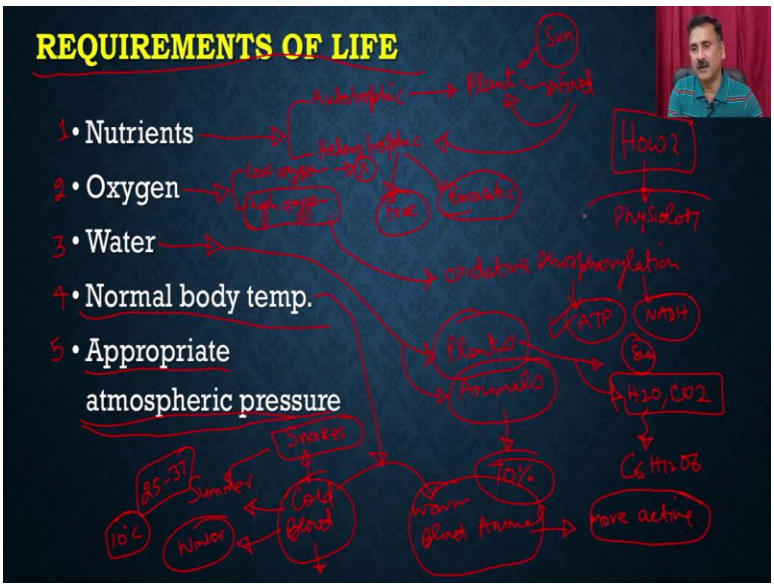

So, if you see that what is the requirement of a life? The requirement of the life is that it requires the nutrients, it requires the oxygen, it requires the water, it requires the normal body temperatures and it also requires the appropriate atmospheric pressure because all of these parameters are, has to be optimal, and then only the organism is actually going to survive.

So, talking about the nutrients, remember that when we were talking about the digestions we said that the mode of nutrition take could be of two types. It could be heterotrophic, it could be a autotrophic or the heterotrophic. So, we can have the autotrophic nutrients or the heterotrophic nutrients. So, within the within the autotrophic we have a classical example of the plants, which are actually utilizing the energy from the sun.

And in that process they are actually preparing the food. This food what they are preparing is being utilized either for their own growth or this food is also been be a source of nutrition for the heterotrophic organisms. And within the heterotrophic organisms you can have the free living organisms or you can have the parasitic organisms. So, we have taken the classical examples of the free living organism, parasitic organisms and as well as the autonomic organisms.

Apart from that, when we talk about the oxygen, So, oxygen is required for running the metabolism. So, oxygen is required for removing the toxicants from the body and oxygen is also required for the different types of purposes. But the organisms are also been classified based on what is the amount of oxygen they require for maintaining their life cycles or maintaining the, So, you can have the organisms which actually require the low oxygen or you can actually have the organism which require the high oxygen.

For example, you can have the bacteria which actually can survive even within the absence of oxygen as well because it can actually go for the anaerobic oxidations and that is how it is actually going to continue running its life cycle. Whereas in the higher organisms you actually require a very high quantity of oxygen because that oxygen is required for running the oxidative phosphorylations. And oxidative phosphorylation is important to generate, the oxidative phosphorylation is important for generating the ATP.

And that ATP as well as the NADH, and that is how it is actually going to contribute in terms of providing the energy into the different types of processes. Remember, when we were talking about or we were discussing about the nervous conductions or even the muscular locomotions, we have said that you require a very continuous supply of the ATP. And then only it can actually be able to continue the, moving from one person to another person.

Then we also require the water. So, water is required for most of the organisms and there is a adequate amount of water is required in the plants and the water is also required for the animals. And the water has a very, its own role in terms of controlling the different types of metabolic reactions. Water is also contributing in terms of the lowering down the temperatures, and water is directly participating into the food formations when we talk about the plants.

So, what is happening in the plant is that it is actually taking the energy from the sun but it is also taking up the water. And it is also taking the carbon dioxide. And that is how this carbon dioxide and water is assimilating with each other and that is how you, it is forming the carbohydrate. Apart from that the water is also being used to cool down the water, cool down the plants.

Otherwise you have seen that the trees and the plants are standing in the in the sun and they keep absorbing the sunlight but they do not get dried up or they do not get any kind of damages because of the only reason that the water is being circulated within the plant body and that is how the water is evaporated through the leaves and other parts of the plants and that is how it is actually giving them the cooling effect.

In the, in the plants, in the animals also the water is, the animal body is approximately more than 70 percent is the water only. So, water is very essential for the continuity of the life. And if you recall when we were talking about the origin of life, the primordial oceans where the cell is being formed, it formed because there was a plenty of water which was actually working as a medium to catalyze the different types of reactions.

Now apart from the water we also require the normal body temperatures. And normal body temperature based on the body temperature the organisms could be of the cold-blooded animals or the warm-blooded animals. So, what is mean by the cold blood animal is that they cannot maintain the temperature of their body, whereas the warm-blooded animals are actually maintaining a contain, a constant temperature of their body. So, that both of these are actually having it their own their own advantages.

Like, for example, the warm blood animals are more active and they are actually remain active throughout the life or throughout the year of the, throughout the year. Whereas the cold blood animals, since they cannot maintain their body temperature, they actually have the same temperature as the outer environment, they will be very active during the summer, and they will be less active during the winter because during the winter the temperature will fall down and because of that the body temperature also will fall down. And that is eventually going to disturb the metabolic reactions.

And that is how, you might have seen that the cold blooded animal, For example, the snakes, So, snakes are very active during the summer because they are actually having

the high temperature So, they can be able to run the different types of metabolic reactions like the glycolysis Krebs cycle and all other metabolic reactions. You know that the, all these metabolic reactions are actually going to be catalyzed by the enzymes and these enzymes require a appropriate high temperature. Then only they will be able to catalyze the reactions.

But that is only possible during the summer when the temperature is actually going to be in the range of to 35 to 37 degree Celsius. But during the winter the temperature will go down, temperature will fall even less than 10 degree. So, at the 10 degree Celsius most of these reactions are not going to happen and most of these reactions will actually suppress, and that is how these cold-blooded animals are actually going to be in a dormant state. So, that is the advantage of having a normal body temperature, or we will say constant temperature.

And then the animals are also require the appropriate atmospheric pressure. So, that atmospheric pressure is required to maintain the body structure and as well as, because if there will be a fluctuation in the atmospheric pressures it is actually going to deform the animals body and that is eventually going to disturb the overall physiology. So, how the animals are actually going to achieve these objectives? So, to achieve these objectives the animals are actually running the physiology.

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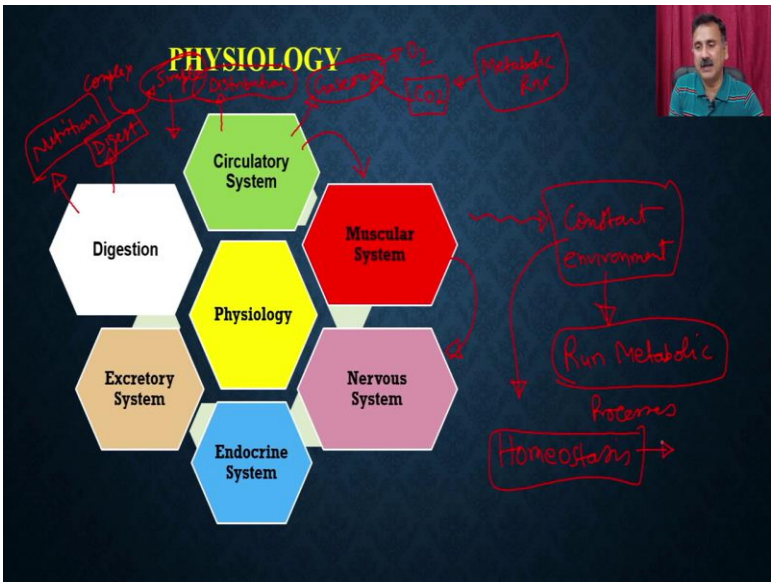

Now, we have discussed about the different types of physiological processes. We have discussed about the digestions and digestion is participating directly in terms of providing the nutrition because it is actually going to digest the complex food. So, it is actually going to digest the complex food, and it is going to make the simple monomeric molecules. These simple monomeric molecules are actually going to be absorbed and that is how they will be available for the further downstream applications.

These simple biomolecules such as glucose, amino acids, fatty acids, glycerol and nucleotides are actually going to be distributed throughout the body by the circulatory system. So, the purpose of the circulatory system is that it is actually going to distribute the food materials, and it is also going to distribute the different types of gases. So, remember, when we were talking about the circulatory system, we said that it actually going to give the free, fresh oxygen.

And in the same process it is actually going to collect the carbon dioxide from the cells because this carbon dioxide is actually going to be formed from the metabolic reactions and this carbon dioxide is not good. Then, we also discuss about the muscular system, nervous system and So, on. Now, the purpose of running the physiological processes is that it want to maintain a constant internal environment.

So, it is actually trying to maintain the constant environment and that constant environment will allow them to run the metabolic processes. And the processes or the metabolic processes, and this phenomena of maintaining the constant environment is also called as the homeostasis. So, if you go by the term homeostasis, that means that you want to maintain the home like environment. So, what are the things are going to happen when you are going to do the homeostasis or how the organism is actually going to maintain the homeostasis.

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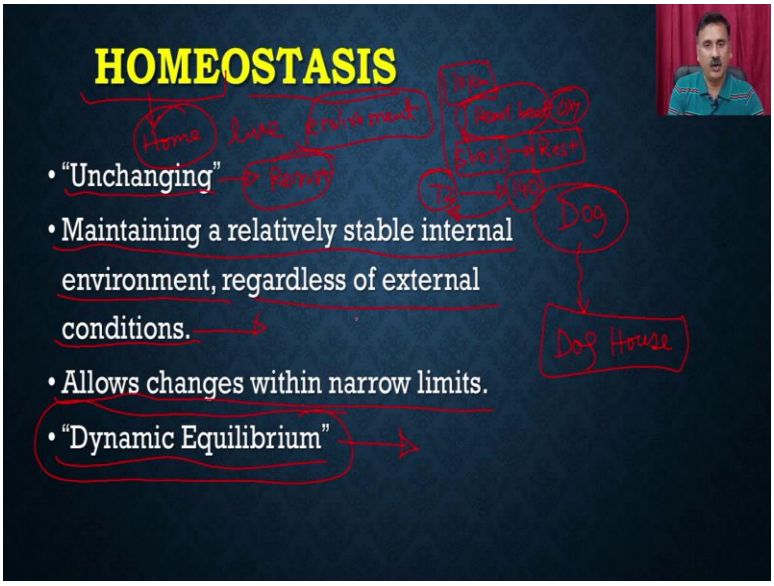

So, as the name suggests the homeostasis means the home and stasis which means home like environment. So, remember that every organism is very happy when they are in their home. If you have kept a dog as a pet, if you kept a dog in your, as a pet in your home, you remember that you it may be roaming around throughout your house but it might be sleeping in his doghouse whenever he is actually going to sleep.

Same is true for the, even our body also. Our body is probably going through with the different types of processes, like it is running the metabolic reaction, it is running the glycolysis Krebs cycle, it is running the oxidative phosphorylation, and So, on, and you might be running from your home to your college and from college to your tuition and all that, but at the end, you are actually trying to maintain or trying to restore what you have started with.

That is why that is what is called as the homeostasis which means the homeostasis is going to be explained as a process which will allow or which will actually going to resist for the changes. So, it will allow, it will, there be a range until which it can allow you to change the micro environment of the body or micro environment of the animals, the particular organism, but it will resist beyond that. And when it resists, it is actually trying to bring the parameter back.

For example, you can run for 10 kilometers. If you run for 10 kilometers, that is actually going to cause a stress to the body or it is going to cause the stress to the organisms. But

that stress is going to be relieved when you are actually going to take the rest because during the resting phase it is actually going to restore the parameter.

For example, when you run from 10 kilometer, your heartbeat will go up, your heartbeat will go up, your oxygen environment, your oxygen requirement is also go up. But all these will come down. When you started with, you probably will have a heartbeat of 72. When you are going to complete your race, your heartbeat could be probably like 140. So, if it will continue like 140, you will be in a problem because your heart is unnecessarily under stress.

So, what will happen is that 140 will again revert back to the 72. So, this is what is called as unchanging, which means it is actually going to resist for the changes in the parameters. So, it will actually going to maintain a relatively stable internal environment regardless of the external conditions. So, this is what we have already explained. You can actually go with the sport activities, you go with the any kind of mental activities and So, on.

That is actually going to cause a stress, that is actually going to induce the changes in your body. But that changes are going to be temporary. Those changes will actually go as long as those parameters are actually going to be removed. It allows the changes within the narrow limit. And the body is actually the under the dynamic equilibrium. So, to understand this phenomena, let us take a few examples.

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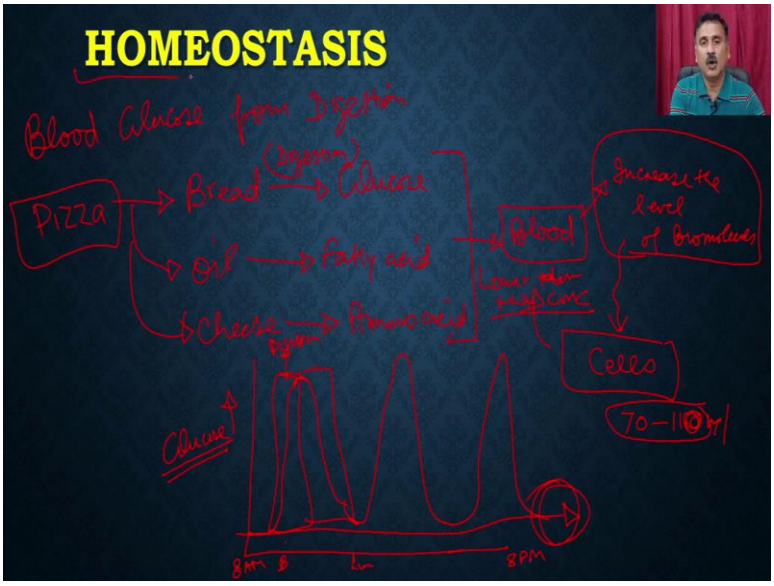

So, we will take an example of the blood glucose, or we take the example from the digestion. Suppose you have taken a bite of pizza. So, what will happen is that the pizza which is, remember that when we were talking about the pizza, it is actually made up of the bread, it is made up of the oil, it is made up of the cheese. And all of these are actually going to give you the different types of the biomolecules.

Like from the bread you are actually going to get the glucose, from the oil, you are actually going to get the fatty acid, and from cheese you are actually going to get the amino acid. So, cheese is a protein, it is actually going to give you the amino acids, oil is a fat, So, it will actually going to give you the fatty acids, and the bread is actually a carbohydrate, the polymeric carbohydrate, So, it will going to give you the glucose.

Which means, as soon as you have taken the pizza, it is gone through the process of digestion. So, this is after the digestion. It is actually going to give you the, very huge quantity of glucose. And all these are actually going to get absorbed into the blood. So, all of a sudden, although the blood will actually going to have the minimum concentration of the fatty acids, minimum concentration of the glucose or the minimum consideration of amino acids, but when you have taken the pizza, it got digested, you are actually going to have the very high quantity of the glucose.

That is how, what will happen, it is actually going to increase the level of the biomolecule. So, it will actually going to increase the level of the biomolecules. And

because of that, So, what will happen? If you do not change this, if you do not change, So, the blood glucose level is actually going to go up, the blood fatty acid level will go up, and blood amino acid level will go up.

But you know that the, there is a limit until one can actually be able to increase. So, what will happen is that from here it will actually will absorb by the different types of cells. So, what will blood will actually going to do is it will going to take up all these biomolecules and then it will actually distribute throughout the body. And that is how the, it is actually going to lower down the concentration, lower down the concentrations of the biomolecules.

If you take an example, for example, if I show you a pattern and if you show like the glucose for example, I will take just a simple example of the glucose. So, glucose is in a range of 70 to 110 milligram per deciliter. So, if I show you how it is actually going to change. So, when you wake up, suppose you wake up at 8 am, and you sleep by 8 pm. So, what will happen is as soon as you wake up, and suppose you have taken a breakfast.

So, if you take in the breakfast, for example, here you have taken the breakfast, as soon as you have taken the breakfast the glucose will go up. And after some time, glucose will come down because this is the phase when the digestion is happening, this is the phase when the digestion is happening. So, this is the phase when the digestion is happening, and the glucose is actually increasing. And this is the phase when the glucose which is present in the blood is actually going to be absorbed by the different types of cells.

Now this is the lunch time. So, as soon as you, again you have taken the lunch it will again go up. And it will again come down, it will again go up, it will again come down. So, this is the way in which you are actually going to have the different types of peaks. And you can take the example of glucose, you can take the example of even the fatty acids or the amino acid.

So, what is actually is the baseline? This is the baseline, which is actually the homeostasis, which is the home like environment. So, it will maintain this environment irrespective of that you are perturbing these conditions by different types of activities. So, this is just a simple example where the body is actually going to respond to the changes.

And it will resist for the changes. And these are the phenomena which are collectively being called as the homeostasis. Now how the homeostasis is going to happen?

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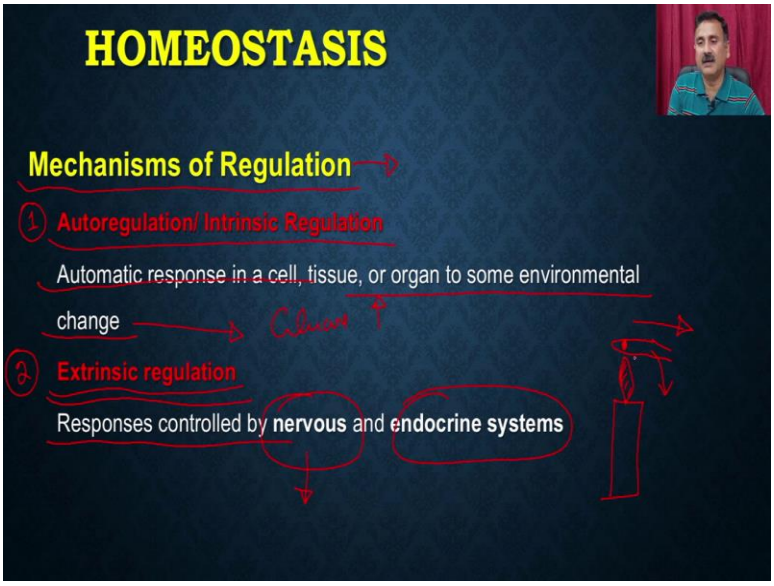

It is actually going to have the mechanism of regulation. So, how the body will know that there is a change in the carbohydrate level or whether there is a change in the glucose level or whether there is a change in the amino acids or the fatty acid level? So, it actually can have the two different types of mechanism it can have the autoregulations or the intrinsic regulations or it can also have the extrinsic regulations.

In the autoregulations, the automatic response in a cell, tissue or organ to the environmental changes. For example, when the glucose will go up, when the glucose will go up, it is actually going to give you the response, and that response is actually going to be monitored by the different types of receptors or different types of machinery, what is present on to the cell tissue or organ, and that is why it is actually going to restore.

Then we have the extrinsic regulation. So, extrinsic regulations are actually going to be controlled by the nervous system or the endocrine system. So, nervous system, we have already discussed. For example, if there will be a heat, suppose there is a candle which is running. So, if there is a candle and it is burning, and suppose you are actually going to touch that candle. So, suppose you touch with your finger. So, what will happen? The finger is actually going to get burned.

So, if your finger is going to be get burn, it is actually going to change the home like environment because you have already given the stress to the body. That time, the nervous system is actually going to take the action. As soon as you touch, it is actually going to say okay, you withdraw your finger. If you withdraw the finger it is actually going to reduce the amount of damage what is going to happen to the finger, and on the other hand it is actually also going to sensitize the remaining area so, that it can be repaired.

Because there will be a burn of the tissue, the remaining tissue is actually going to start the healing processes. So, if you successfully want to maintain the homeostasis like the home-like environment the cell or the body has a very systematic machinery. So, what are the components are present in that machinery.

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These are the components what are present in the homeostasis machinery. You have a stimulus, you have the sensors, we have the integrators. So, the homeostasis is actually not a single process, it is multiple processes what is actually going to function to maintain the home like environment. And that is why you actually require a well-defined homeostasis machinery.

So, what you have, you have a stimulus, you have the sensors, you have the integrators, you have the effectors, then we have the response, and ultimately there will be a result. The result is going to be decide whether I have to change the conditions, whether I have

to activate what machinery and all that. Let us see what are the function of these different components of the homeostasis machinery.

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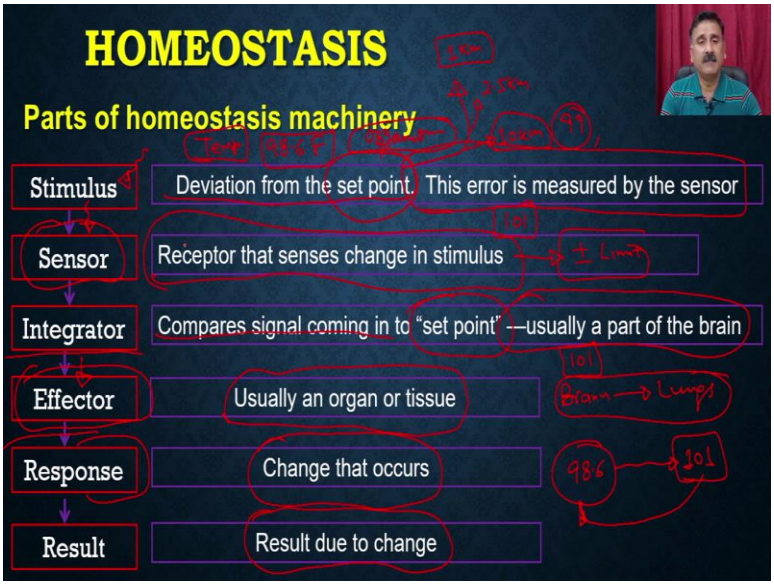

So, stimulus. What we will actually going to cause the stimulus? So, deviation from the set point, So, this set point could be different for the different organisms. So, there is no hard and fast rule that you have this particular set point. And these set points also can be modulated. For example, when you are actually going to start running the first time you cannot be run beyond for example, 1 kilometer.

Because after 1 kilometer your heartbeat will go up, your, you will be get exhausted and So, on. So, this is a set point. After this you are actually changing your home like environment or homely environment to such an extent that body will say no I will not allow you to run anymore because you have already crossed the set point, and you have crossed it beyond it.

But what will happen if you keep continuing, if you keep running for every day, your set point will actually will go up. It will actually be going to be 2.5 kilometers initially, then it will going to be 10 kilometer and So, on. And that is what exactly happens in the athletes.

Athletes are initially starting, they So, they will have a very low stamina. And that is how their set point is low. Their threshold for oxygen is going to be low, their threshold for

the amount of ATP what they can use, the threshold for increasing the heartbeat also and muscular power and all that is actually going to be set point for very low level. As soon as they run they actually can change the set point, and that is how they can be able to increase the set point.

Beyond this set point the error is actually going to measured for the sensor. For example, if you talk about the amount of ATP is present, that could be a set point, amount of oxygen what is present in the body, that could be a set point and So, on. So, all these physiological as well as the physical parameters could be a set point. For example, human body, human body temperature, for example, temperature could be a set point.

So, temperature will say okay, 98.6 Fahrenheit, if that is the set point. But there is a deviation. There is a deviation. It will not going to respond even if the temperature will like be 99. So, it will say, oh this is within the range. So, there is a range. So, this will not going to function but if its temperature is actually going to be 101, then it says okay, you have a fever, and that is how the you have deviated a lot from the set point and that is how it is actually going to respond.

But some of the parameters probably can be modulated and you can actually be able to change the set point. For example, the amount of oxygen what the lungs can actually be able to capture. It depends how much you train your body and that is how you can be able to change the set point. Then once there will be a deviation, So, it is actually going to cause a stimulus to the system.

That stimulus is actually going to be received by a sensory machinery. So, you actually require a thermometer, for example. So, there will be a change in temperature, that will be the stimulus, and then you require a machinery So, that you can be able to measure how much actually deviation happened. And that is the sensor, that is the function of the sensor. So, receptors that actually are actually going to sense in the change.

And that is only going to say whether the changes are within the limit. So, if it is within the limit, it is not going to respond, it is not going to give any signal to the integrator and effector and response, but it will, if it is beyond this particular limit then it is actually going to give the signal to the integrator.

What is the function of the integrator? It is actually going to compare the signal what is coming, So, it is going to say oh temperature is 98.6, So, it is within the set point. If the temperature is 99, okay, it is still be in the, within the range. But if it is temperature 101, then it will say oh, it is beyond. So, I should actually inform the integrator. And what is integrated, integrator is actually going to be a part of the brain because you have to send the signal to the brain saying that something is going wrong.

Something is going wrong in the body because of that the temperature is now 101. It is actually beyond that, or my oxygen level is going down or my breath is actually not complete because you are running. So, if you are running, you become exhausted. So, that time also there will be a signal which will go to the brain and say that okay you have to take rest, you have to stop and you have to breathe heavily So, that you can be able to compensate.

Then after the integrator, it is actually going to give the signal to the effector. Effector is going to be the usually a organ. For example, in this case the brain or the brain will actually going to give the signal to the lungs. For example, if you are short of the oxygen or short of the breath, then it will say oh, lungs has to function more properly. And that is how it will say, stop take the deep breath So, that it will actually compensate for the loss of the oxygen.

And that is the point where you can actually be able to increase your set point. I am sure you might have seen that when we people are started with the playing a particular game, they will be having a very low stamina. And there are So, many examples where you can be able to change or modulate this particular process. And once the usually organ or tissue is going to be an effector, it is actually going to give you the response.

So, it will say okay, what should be done. If the temperature has gone up, what should I do, and that is the change what is actually going to induce that change. And that induced change is actually going to results into the deviation. So, it is, suppose that the set point is 98.6 and the actual temperature is 101. So, what will happen? Because of these responses, the body will try to close, try to bring the 101 as closer as to 98.6 by many of the activities.

For example, you may start sweating, there will be shivering, there will be So, many things. So, that is how, these are the basic processes through which the body is actually going to respond to the increase in temperature. Now, the question comes when you are running this particular type of complicated machinery you can be able to run it in a multiple modes or multiple way.

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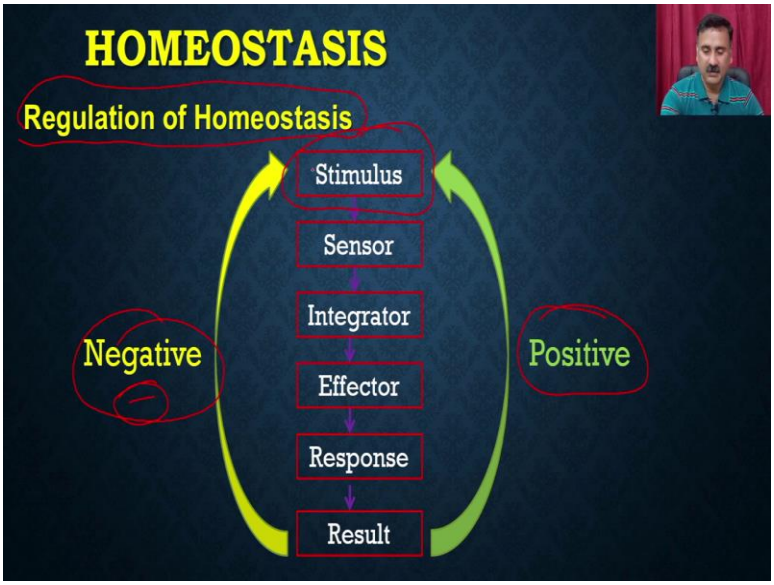

So, this regulation of the homeostasis could be of two types. It could be a negative regulations where you are actually going to be run this, integrate, run this complicated machinery and that is how it is actually going to be a negative regulations, or it could be a positive regulation.

So, positive regulation is actually going to results into the increase in the stimulus which means it is actually going to make the condition even worst, whereas the negative regulation means it is actually, the result whatever it comes, says, it is actually going to take care of the stimulus, it means it is actually going to reduce the level of the stimulus.

Let us see what is the difference of, or what are the properties of the negative as well as the positive regulations.

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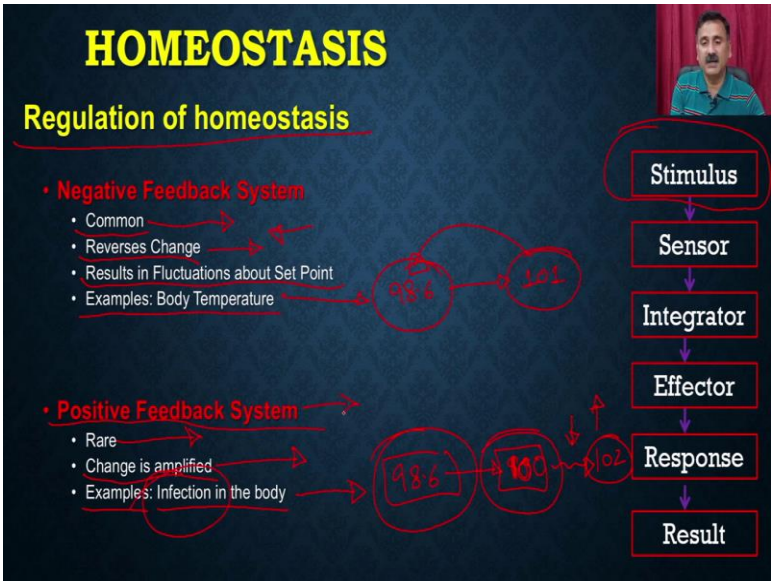

So, in the regulation of the homeostasis you have the two system, you have the negative feedback mechanism as well as the positive feedback mechanism. Negative feedback mechanism is very common. So, it is actually, whatever we have just now discussed, it is all part of the negative feedback mechanisms. It actually going to reverse the changes, which means if there will be an increase in temperature, it is actually going to decrease the temperature.

Then it is actually results in the fluctuation about the set point. For example, the body temperature. So, body temperature is 98.6. If it goes to 101, the negative feedback mechanism is actually going to bring the temperature back to 98.6 or closer to this value as much as possible by its own natural way.

Then, we have the positive feedback mechanism. Positive feedback mechanism is very rare. It happens in a very, very strange situations. So, it is not something which is happening on a daily basis, but sometime it happens. One of the characteristics of the positive feedback is that it is actually going to change the amplified, it is actually going to increase the stimulus, which means it is actually going to increase the initial input.

And example is that there is a infection in the body. For example, when you have the infection in the body, then the same thing is actually going to change in a different way. For example, you are actually going to have the, For example, you have the fever of 100

degree, and So, this is a standard body temperature, it goes up to 100, it will actually increase even further up.

Because in the case of infection, it is actually increasing the temperature and that is how it is actually trying to use the temperature as a weapon to kill the microorganism. And that is how it is actually trying to get rid of the particular infection. So, the positive feedback mechanism is very rare. It happens in a very, very strange situations and in most of the cases it is actually going to amplify the stimulus.

Which means, remember that here we only have the 101 signal, and that is how it has given the signal that, and that is how we have it reduces the temperature, but in this case the temperature, as soon as even if temperature gone to 100, 101, it will increase further So, that it will be keep increasing until the infection is got cleared. So, the positive feedback mechanisms are very rare.

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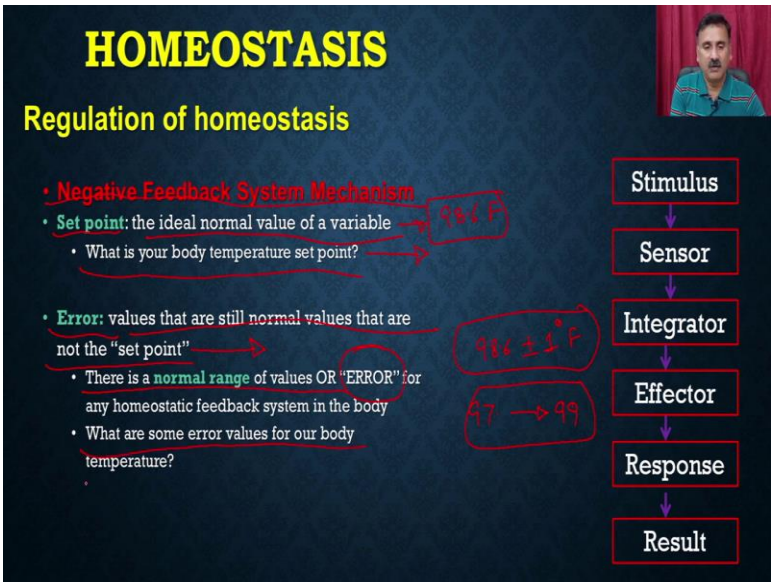

Now, how the negative feedback mechanism is actually going to work? So, you have the set points, the ideal normal value of a variable, For example, the temperature 98.6 Fahrenheit. So, it will say what is the body temperature set point? So, if you can actually change the set points, you can actually be able to change the set points, but for example, that for different organisms the set point could be different. For humans, it is 98.6, therefore other organisms it could be different.

Then it will say error. So, the value which is still normal, not the set point, about the set point. So, there is a normal range of the value or the error, which means it will say that 98.6 plus minus 1 degree Fahrenheit. So, it will say even the temperature will go down to 97 or if the temperature will go down to 99, I will not going to respond because this is within the error limit. What are the some error values for our body temperature?

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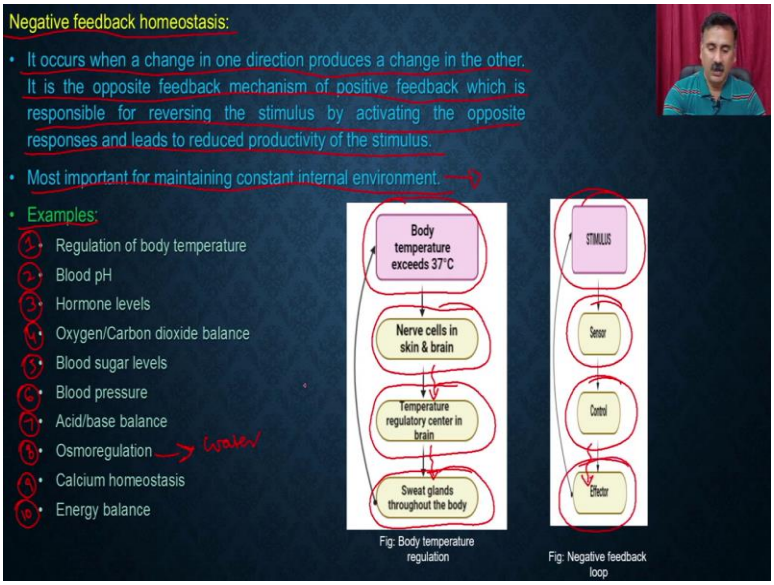

Fig: Body temperature regulation

Fig: Negative feedback loop

Now, in a negative feedback mechanisms, it occurs when a change in one direction produce a change in the other. It is the opposite feedback mechanism of positive feedback, which is responsible for reversing the stimulus by activating the opposite responses, and leads to the reduced production of the stimulus.

Most important for maintaining the constant internal environment, So, negative feedback mechanism or the negative feedback homeostasis is important for maintaining the normal internal temperatures. There are So, many examples where the negative feedback mechanism is going to work.

For example, we have the regulation of body temperatures, we have the blood pH, we have the hormone levels, we have the oxygen or the carbon dioxide balance, then we have the blood sugar, blood pressure, acid-base balance, osmoregulation which means the amount of water what is present in the body, and the calcium homeostasis and as well as energy balance.

And in a any given temperature or in any given condition, So, what will happen is that you are actually going to have the normal body temperature, and that normal body temperature, if it goes beyond that it is actually going to give you the signal to the nerve cells or skin in the brain, and that is actually going to give the signal to the thermal receptors into the brain.

And once the signal will go to the brain thermal receptors, it will say okay, there is a increase in temperature. So, what I will do is I will change or I will do something. So, what it will do is it will actually going to activate the sweat glands. And the sweat glands are actually going to start pouring the liquids.

So, once the sweat glands are start pouring the liquids it is actually going to evaporate from your skin and that is how it is actually going to lower down the temperature. That is exactly what happens even in a normal circumstances. When you run from one place to another place you might have seen that you sweat a lot because, because of the running the body temperature actually goes up because of the So, much muscular activities.

Because remember that when muscles are running from one part, they are actually rubbing to each other, and because of that it is actually causing the large quantity of the heat productions. And So, because of that, the body goes, body's temperature goes up. And that gives the signal to the brain, and that is how the brain is started activating the sweat glands, and that is how the sweats are started coming.

So, in a negative feedback mechanism, you have a stimulus, it is actually going to be received by the sensor. For example, in this case, the thermal sensors. And then it will go to the organs like, in this case, the brain, and then ultimately to the sweat glands, and then it is actually going to start having the effector functions. Now I will take the few of the examples of the negative feedback homeostasis, how it functions.

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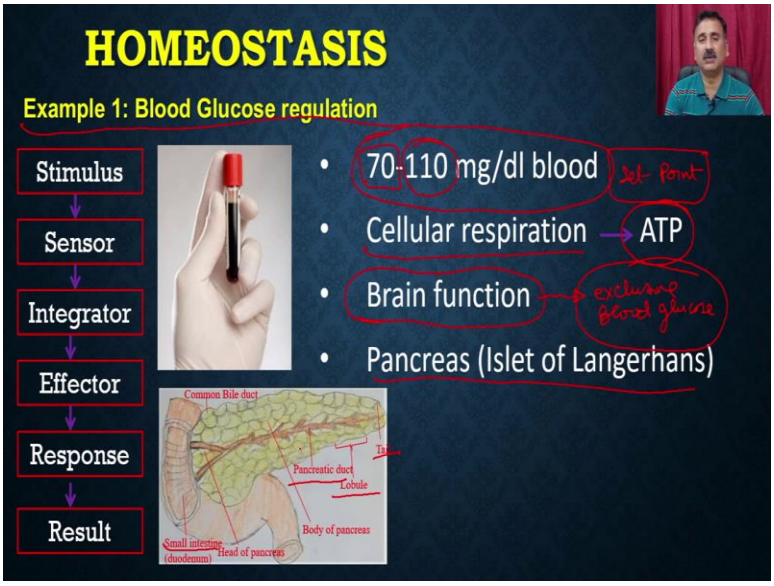

So, one of the classical examples is the blood glucose regulations. So, in a blood glucose level, you have the standard blood glucose level. So, this is the set point. So, this is the set point in which, and you see the range. So, it starts from 70 and goes up to 110. So, if you have, this is the error what you have within the blood glucose level. So, you can have a level of 70, you can have a level of 110, and that depends on the type of body or type of the lifestyle what you are achieving.

And once the, and why we require the blood glucose, we require the blood glucose for the cellular respiration because it is actually going to be a source of ATP, and the brain functions. So, ATP, So, blood glucose is very, very important for the brain functions because the brain is an organ which is exclusively taking the blood glucose. So, it is not taking any other source of energy, it is only taking the glucose or the carbohydrates.

And then once the blood glucose level will go up, we also have the pancreas which is actually going to participate into the blood glucose regulations. So, this is what you see here. It is the pancreas and this is what is showing as the blood glucose, blood, what we have been withdrawn to determine the level of glucose.

So, in the pancreas what you have is you have the pancreatic ducts, you have the lobules, you have tails, So, the, and we have the, this is the small intestine through which, in which the pancreas is actually delivering all its content. Remember that when we were

talking about the digestions, we discussed about the pancreas and how the pancreatic enzymes are participating into the digestion of the different types of biomolecules.

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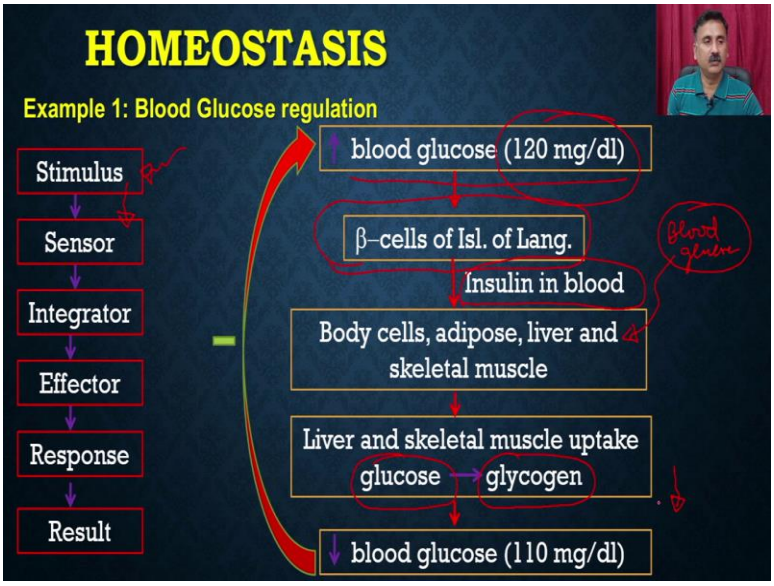

So, once the blood glucose, For example, here I have taken an example that the blood glucose is now 120 per deciliter. So, as soon as that happens, it is actually going to be a stimulus, So, it is going to be a stimulus and that stimulus is actually going to be received by the cellular machinery, and that is how it is actually going to induce the beta cells of the pancreas, and that is how they will be actually started secreting the insulin.

And once the insulin is going to be produced, the insulin is actually going to mobilize the uptake of the glucose from the blood. So, what will happen is that the blood glucose is actually going to be taken up by the cells of the body cells, adipose, livers and skeleton muscles, and that is how once you take up the blood glucose, it is actually going to lower down.

And within this, these organs, what will happen is that the glucose what you have taken up from the blood glucose is actually going to be get converted into the glycogen. And once you convert the glucose into the glycogen it is actually going to reduce the level of glucose into the environment.

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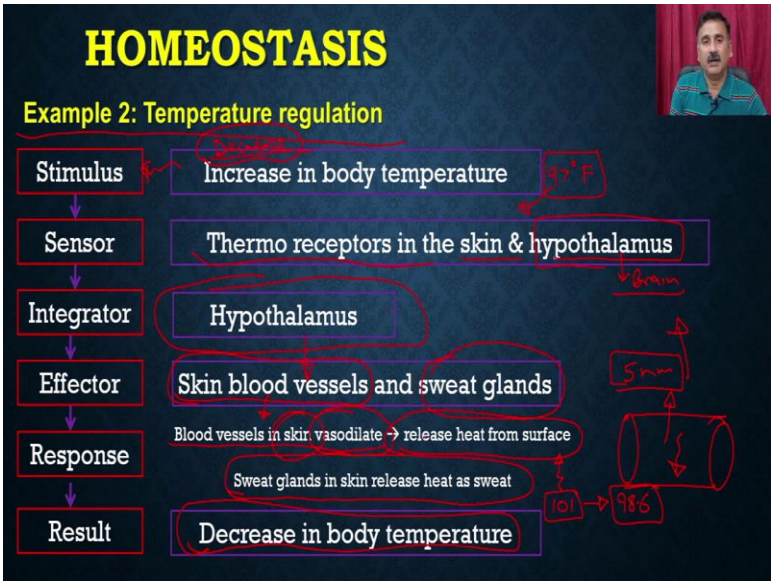

Now, we take the another example. So, another example is the temperature regulations. And the temperature regulation is going to be stimulated by increase in the body temperature. So, it could be increase or decrease actually. So, it is going to be change in the temperature, of the body temperature, that is going to be a stimulus for the homocystic machinery.

Once that happens, it is actually going to activate the, it is going to be sensed by the thermoreceptors in the skin as well as the hypothalamus. So, hypothalamus is a part of the brain which is actually going to function. And then it is actually going to go to the hypothalamus for effector functions, and the hypothalamus is actually going to activate the cellular machinery, and it is actually going to activate the skin blood vessels.

So, it is going to activate the skin blood vessels, and it is also going to activate the sweat glands. So, skin blood vessels, what they will do, they will actually, there will be a dilation of the blood vessels, and once there will be a dilation of the blood vessels, it is actually going to release the heat from the surface.

Which means, if you have the 5 mm of the area, you are actually going to have the more heat because heat is, the increase in temperature will be directly proportional to the amount of area of what you have. But if you do the vasodilation, the blood vessels are actually going to be get dilated and because of that it is actually going to release the heat

from that particular surface area, and that is how it is actually going to lower down the temperature.

The other mechanism is that it is actually going to activate the sweat glands and that sweat gland is actually going to release the sweats, and that sweat is actually going to evaporate. So, when it evaporates, it is actually going to take up the energy or the heat what is present with the higher temperature.

So, for example, if you have the temperature of 101, and if there will be a sweat gland or if there will be a sweat on the body, it is actually going to consume the energy or consume the heat from the skin. And that is how the temperature will come down to 98.6. And that is going to be, ultimately results into the decrease in the body temperature.

Now you can imagine that if the decrease in the body temperature could be a stimulus, all these activities are actually going to participate into a reverse mode. For example, if there will be a decrease in temperature, there could be a condition when you are actually going to be having a decrease in body temperature.

For example, if someone is having a body temperature of 97 degree Celsius, 97 degree Fahrenheit, in that case all these machinery will remain the same. It is going to be sensed by the thermal receptors in the skin and the hypothalamus, then hypothalamus is actually going to activate the skin blood vessels and the sweat gland, but the effects are going to, all the responses are going to be reverse.

For example, in this case it is actually got the vasodilation of the skin, in that case it is going to be vasoconstriction because you are trying to increase the temperature. So, if the temperature is low, you are trying to increase the temperature, you have to do a vasoconstriction, which means you have to reduce the skin surface area.

And that is actually going to restore the heat from the surface and that is how it is actually going to increase the temperature of the skin. Same is true for the sweat glands. So, if it does not going to activate the sweat gland, it is not going to lower down the temperature. So, this is all about the negative feedback homeostasis.

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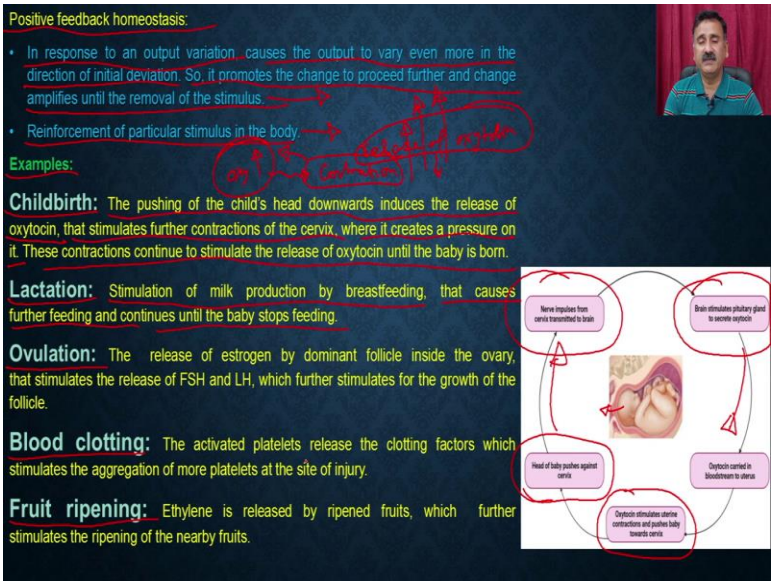

Now, let us talk about the positive feedback homeostasis So, in response to an output variation causes the output to vary even more in the direction of the initiation deviation So, it prompts a change to proceed further and change amplified until the removal of the stress. So, remember that when we were discussing about the positive feedback homeostasis it is actually going to increase the initial output, So, reinforce the particular stimulus into the body.

The examples, childbirth, lactations, ovulations, blood clotting and the fruit ripening. So, childbirth, for example. The pushing of the child's head on downwards induces the release of the oxytocin. So, as soon as you have the release of oxytocin, it is going to induce the head, downwards movement of the baby. So, it is actually going to induce the downwards, So, it is going to be induce the movements within the uterus.

And that stimulates the contraction of the cervix, where it creates a pressure on it. This contraction continue to stimulate in the release of the hormone. So, you are actually having a response where the oxidation level gone up, So, oxidation level gone up, So, this is the initial stimulus, So, it could have been the negative feedback, the stimulus could have been lowered down.

So, that is inducing the contractions within the uterus. But in the positive feedback mechanism, the oxidation level will be keep rising, these contractions are further stimulating the production of oxytocin, and that is how the contraction will be keep

increasing, keep increasing, and keep increasing, and that is how the baby is going to be born.

So, this is what is happening. When there will be a oxytocin stimulus, it is actually going to induce the contraction of the uterus muscles, and it is actually going to, the baby is actually going to move towards the downstream. And the baby's head is actually going to push against the cervix.

And that itself is actually going to give the nerve impulse to the brain, through the brain, and it is actually going to say there will be more production of oxytocin, and that is how it is actually going to give you the more production of the oxytocin, and ultimately it is actually going to increase the initial stimulus. So, that is what is called as the positive feedback mechanism.

Similarly, during the lactation also the lactation is also being controlled by the different types of hormones, and it also is goes in the same way. As the baby sucks the milk from the breast, it induces the production of more and more milk. So, the stimulation of the milk production by the breast feeding, that causes the further feeding and continue until the baby stops feeding.

So, that is a initial stimulus that the baby wants more amount of milk, and that is how it is sucking the, whatever the milk is present and that induces the production of more amount of milk. Same is true for the ovulations, blood clotting and as well as the fruit ripening. So, we have discussed about the negative feedback mechanism, we have discussed about the positive feedback mechanisms, now let us see what are the classical differences or contrasting features of the positive as well as the negative feedback mechanisms.

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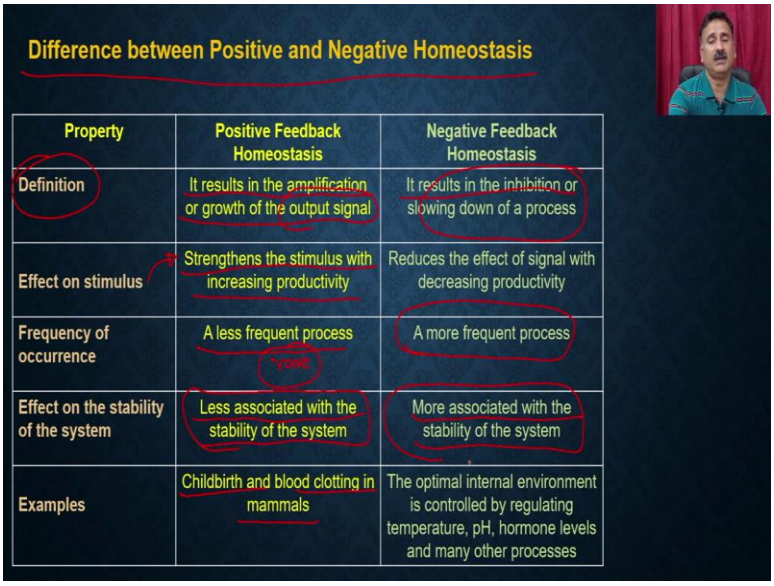

So, what are the difference between the positive as well as the negative feedback mechanisms. So, one of the major difference is that the positive feedback mechanism will results in the amplification of the output signal, which means it is actually going to increase the input signal, whereas the negative feedback mechanism, it is going to have the inhibition or the slowing down of the process.

Apart from that, the most of these parameters are actually going to be according to this. For example, the effect of stimulus it is actually going to strengthen these stimulus with increasing the productivity, whereas in this case it is actually going to reduce. Then frequency of occurrence, the positive feedback mechanisms are very rare because it happens in a very straight special condition, For example, the childbirth.

So, childbirth is a very strange and rare conditions in which the positive feedback mechanisms are going to operate, whereas negative feedback mechanisms are very frequent. For example, you always have the temperature fluctuations, heartbeat fluctuations, and blah blah blah, and that happens on a daily basis.

Effect on the stability of the system, it is less associated with the stability of the system. So, positive feedback mechanisms are not been meant for bringing the homeostasis back to the set points actually. They are very, they are actually operating for a special reason and that is how they are actually functioning, whereas in the case of negative feedback mechanism, they are more associated with the stability of the system.

Examples, childbirth, blood clotting in the mammals, whereas here we have the many examples like thermoregulations, pH maintenance, hormonal levels, and many of these processes. So, apart from these differences, there could be a similarity between the positive as well as the negative feedback homeostasis mechanisms.

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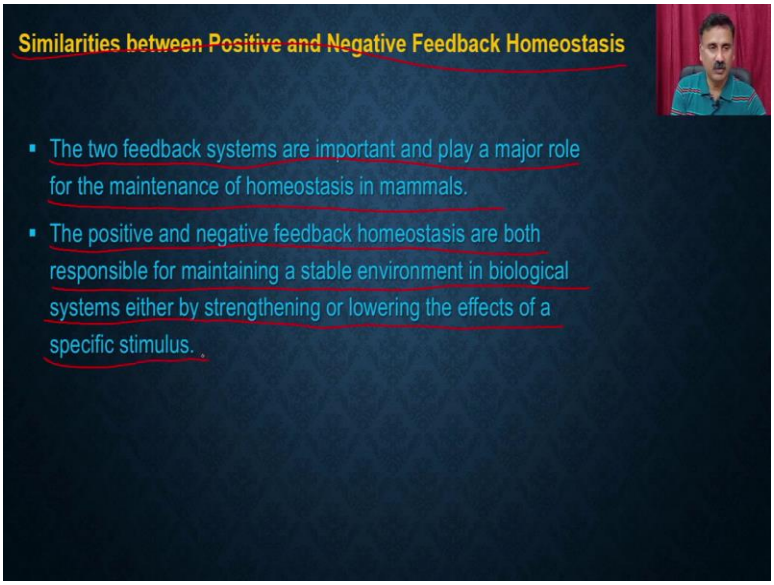

So, what is the similarities? Similarity between the positive and the negative feedback mechanism is that the two feedback mechanisms are important, and they play a major role for the maintenance of the homeostasis in the mammals. The positive and the negative feedback, homeostasis are both responsible for maintaining a stable environment in the biological system either by strengthening or lowering the effect of a specific stimulus. So, this is all about the homeostasis.

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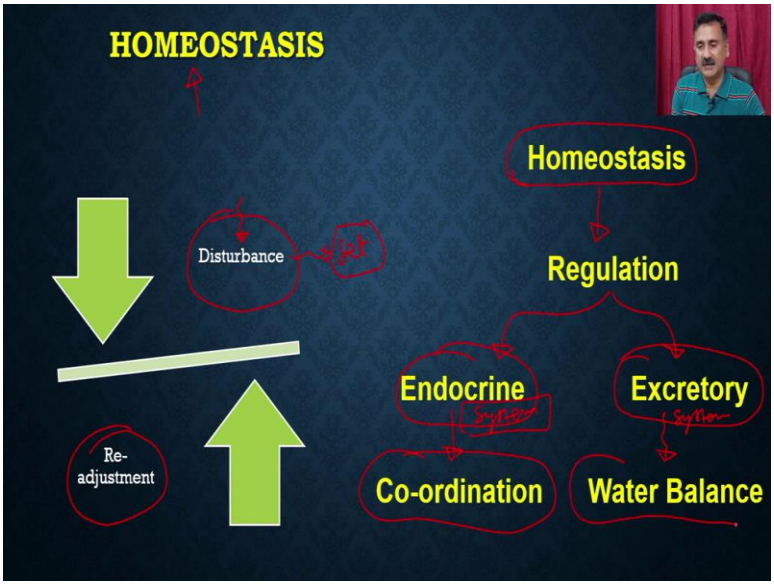

What we have discussed, we have discussed about that that there will be a disturbance into the set points, So, that disturbance into the set points are actually going to bring the changes into the organisms and that is how it requires the readjustments. And that readjustment is actually going to, So, this disturbance and as well as the way adjustment are continuously being operating to maintain the constant environment of the body, and that is called as the homeostasis.

So, if you want to have the, if you want to have the constant environment or the homeostasis, it requires a very, very integrated mechanism of regulations where you can have the positive regulations or the negative regulations. And within these regulations, we can have the two component of the regulation. One is the endocrine function, endocrine regulations or the excitatory regulations. So, within the endocrine regulation which is required for coordinating the different types of activities.

Remember that we have So, many, So, much the discrete mechanism or the machinery of the homeostasis like where you have the stimulus, stimulating machinery, effectors, and all that but the coordination among them is very important, and that has been always been done by the endocrine functions or endocrine system of the body. Whereas the osmoregulations and other things are actually going to be done by the excitatory systems. So, that is going to have the role in the water balance.

So, this is all about the different types of processes what are been responsible for maintaining the homeostasis within the organisms. What we have discussed, we have discussed about the homeostasis machinery, we discussed about the regulatory mechanisms of the homeostasis, we have discussed about the negative as well as the positive feedback mechanisms and how these feedback mechanisms are operating under the different conditions.

Within the negative feedback mechanisms which is very common and it is happening on a daily basis where it is very crucial for maintaining the different types of parameters. For example, it is required for maintaining the body temperatures, pH and so on, whereas in the positive feedback mechanism it is rare, it happens in a special circumstances, For example, the childbirth and so on. But both of these feedback mechanisms have their own relevance and as well as the contribution in maintaining the homeostasis.

So, with this brief discussion about the homeostasis, I would like to conclude my lecture here. In our subsequent lecture, we are going to discuss more about the endocrine as well as the excretory functions to maintain the homeostasis in the organisms. Thank you.