Basics of Biology
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Lecture 36
Digestion (Part I)

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 living organism and in that context so far what we have discussed we have discussed about the classification of the living organisms and then we have also discussed about the various other aspects related to the living organism such as the evolution, we have discussed about the prokaryotic as well as the eukaryotic cells and then we also discuss about the different types of biomolecules such as proteins, lipids, carbohydrates, nucleic acids, and then we have also understand how these molecules are regulating the different types of cellular processes.

And now, in today's, so in the previous module, we were discussing about the different types of cellular processes, such, like whether they are the cellular processes related to the central dogma of life or whether they are cellular processes related to the specialized functions. So, in the specialized function, we have discussed about the like the phagocytosis, we have discussed about the immune responses and so on.

And in the, and we also discussed about the vesicular trafficking system. So, in the current module, we are going to start discussing about the new topic and where we are going to understand how the different types of cells which are actually performing the different types of functions are coming together and performing a particular physiological functions.

So, in today's module we are going to start discussing about the physiology. So, when we say about the physiology, physiology is a combined term which is actually been known as the field of science, which actually going to study how the different types of processes are actually being performed within the body or within the organisms and how these functions are actually being utilized by the organisms for their welfare.

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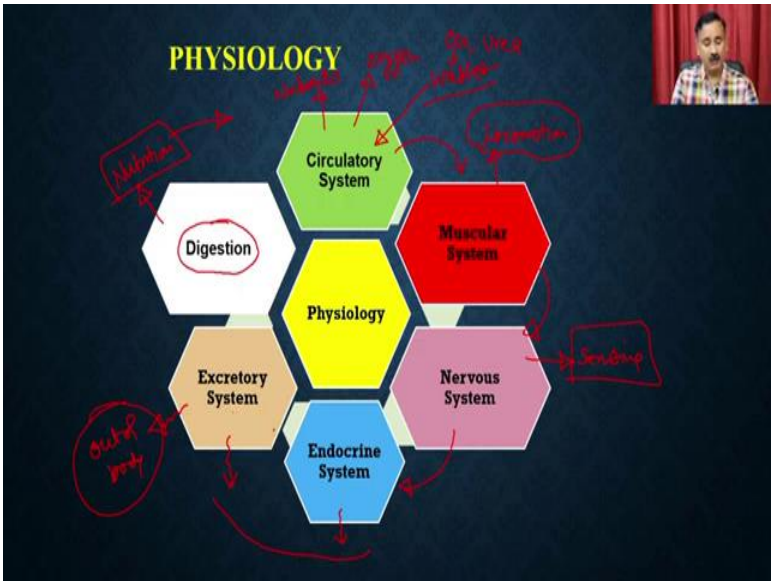

So, when we talk about the physiology, the physiology can be further dissected into as per the different types of purposes, for example, we can talk about the digestion. So, digestion is required for taking up the nutrition from the external sources. Then once you have generated the nutrients, these nutrients has to be circulated or nutrient has to be distributed throughout the different types of cells and that is the function of the circulatory system. So, circulatory system is actually going to distribute the material, so it is going to distribute the nutrients and as well as it is also going to distribute the oxygen or the gases, and in return, it also going to collect the waste material.

So, the circulatory system is which actually going to circulate the fluid throughout the body and in that process it is actually going to provide the nutrients to the different types of cells. It also provide the oxygen and so that the nutrients can be oxidized with the help of the different types of metabolic reactions. And then in return when the metabolic reactions are going to produce the different types of waste such as the carbon dioxide or urea that is actually going to be collected also by the circulatory system and then it is actually going to be put it into the excretory systems.

Apart from the circulatory system we can also discuss about the muscular system. So, muscular system is required for the locomotion. So, different types of organisms are using the different types of muscular system. So, in this case, we are actually, since we are only focusing on the human physiology, we are going to discuss about the muscular system of the human system. And

then we also going to discuss about the nervous system. So, nervous system is required for sensing the different types of responses and it also allows that or it also is going to govern or decide whether what action you should take. So, once you senses that there is a fear, there is a danger, then it is actually asking the organism to prepare for these kinds of signals.

Apart from that the nervous system, we are also going to discuss about the endocrine system and the excretory system. So, endocrine system and the excretory system is required because it is actually going to regulate the activities what is happening in the other organ systems such as the digestion circulatory system, muscular or nervous system. And excretory system is going to receive the material from the circulatory system and that is how they are actually going to excrete the waste material out of the body.

So, what you can see here is that we started with the digestion so that you can actually understand how the humans are receiving the nutrition, and then once it start receiving the nutrients that nutrient can be distributed. So, we also will understand how the nutrients can be distributed throughout the body. And then once you have acquired the nutrients, you are actually going to utilize that for producing the energy and that energy can be utilized for the locomotion so that you can move from one place to another place. Majority of the activities, even the speaking it also been regulated by the muscular system.

And then you can also discuss about the nervous system which is actually been required for sensing the different types of signals. And according to the signal you are actually going to, this nervous system is going to give the instruction to the organisms and that is how the organism is going to behave. And then we also going to talk about the endocrine as well as the excretory systems.

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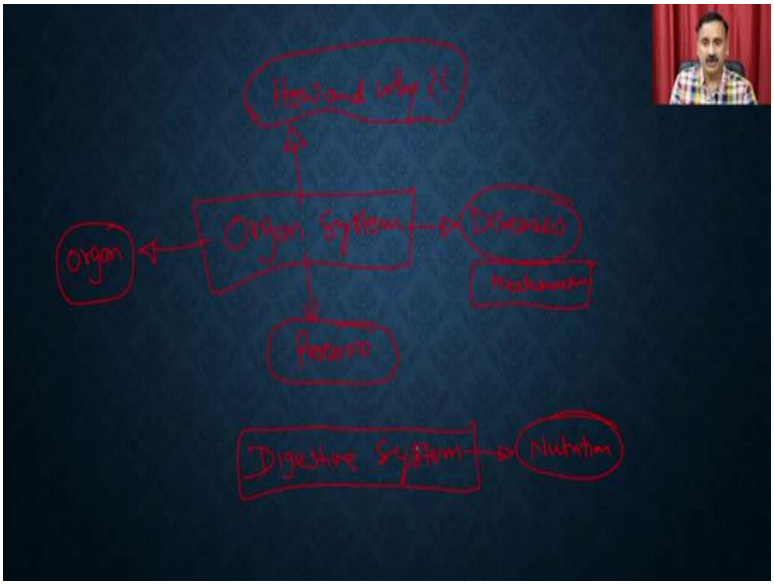

So, when we talk about the any kind of organ system, we are actually going to focus on the few aspects. So, when we talk about the organ system, organ system is meant for a particular type of functions, like just know what we have discussed. The digestion is required for acquiring the nutrition. So, what we are going to discuss in this particular module will is how and why is this particular organ system is required? So, that is a question what we are going to answer.

And then since the we are talking about the organ system, the organ system is going to made up of the different types of organs or the organs components. So, that organs also we are going to discuss. Then we also going to discuss the process. How the organs, these organ systems are coming together and performing that particular process. So, that the organ system is providing the particular type of need. And ultimately, we are also going to discuss about the different types of diseases. In case, the any of these processes are not functioning properly that then the organism is going to develop the different types of diseases.

So, what we are going to discuss when we are going to talk about, when we are going to take up any of the organ system, we are going to say what is the requirement of this organ system, how and why. Then we are also going to understand about the structure and as well as the function of the individual components or the individual organs which are participating and coming together. And then we also going to discuss about the processes, what is happening in these organs. And

then ultimately if these processes are not functioning, how you are going to develop the different types of diseases and what could be the mechanism of the development of these diseases.

So, let us start discussing about the first organ system and the first organ system is the digestive system. So, as the name suggests, the digestive system is required for acquiring the nutrition. So let us before getting into the detail of the digestive system, we are going to start discussing about the nutrition.

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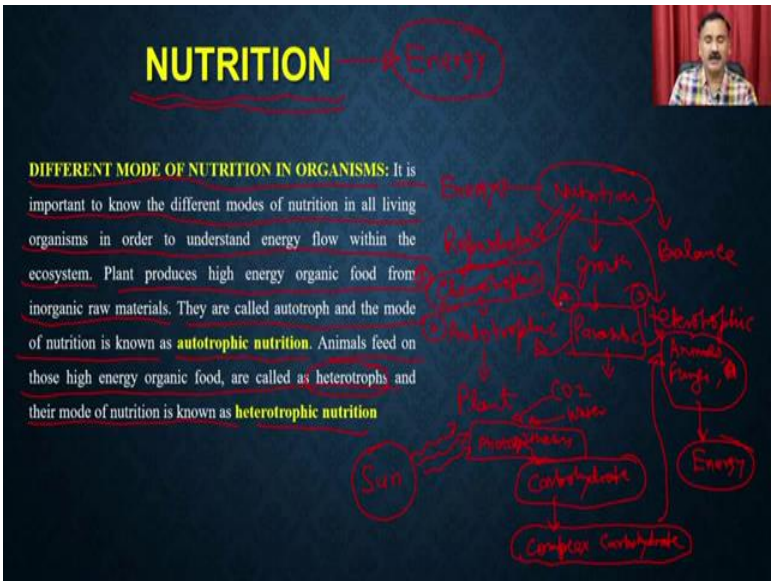

So, when we say nutrition means you are actually going to acquire the some kind of food or some kind of material which is actually going to provide you the energy. And when we say about the energy, the acquiring the energy from the nutrients is actually going to be different. And that is why there are different modes of nutrition in the different types of organisms.

So, different modes of the nutrition in the organism; so it is important to know the different modes of nutrition in all living organism in order to understand the energy flow within the ecosystem. Plant produce the high energy organic food from the inorganic raw material. They are called as the autotroph and the mode of nutrition is known as the autotrophic nutrition. Animals feed on those high energy organic food and they are called as the heterotrophs and this mode of nutrition is known as the heterotrophic nutrition.

So, as per the nutrition is concerned, nutrition is actually being required for the multiple purposes like nutrition is required for acquiring the energy, nutrition is required for reproduction or different types of functions. So, nutrition is required for the production, nutrition is required for the growth because you can use this energy to, for the growth also and the nutrition is also required for the maintaining the balance so that you can actually be able to live longer period of time.

And because the nutrition is the utmost important thing for running the different types of metabolic reaction that is how you are actually going to acquire the energy, the nutrition can be acquired in two ways, one is called as the autotrophic nutrition and the other is called as the heterotrophic nutrition.

So, the plants are actually utilizing the sun. So, in the autotrophic you have the plants and the plants are actually acquiring the solar light. They are actually trapping the solar light from the sun and utilizing this solar energy they are actually producing the different types of food material. So, they are actually producing the carbohydrate with the help of the atmospheric gases. So, plants are actually taking up the carbon dioxide, they are taking up the water and then they are actually utilizing or trapping the sunlight from the, and that is how they are actually been able to synthesize the carbohydrate with the process which is called as the photosynthesis.

And since this course is very limited, we are not going to discuss and give you the detail about the photosynthesis. And once the carbohydrate is being synthesized, initially you are going to have the simple carbohydrates and then it is actually going to give you the complex carbohydrate because that simple carbohydrate is going to be processed and then the simple carbohydrate molecules are going to be joined together and then it is actually going to generate the complex carbohydrate.

Complex, when I say complex carbohydrate means it is going to generate the polymeric carbohydrates such as the glycogen or the starch. And once you have the complex carbohydrates, then this complex carbohydrate is going to be taken up by the heterotrophs such as the animals and the fungi, and then they are actually going to utilize that for producing the energy.

Apart from that these two modes you can also have the different third mode of the taking up the nutrition and that is called as parasitic nutrition. So, parasitic mode of nutrition is where the

organism is actually going to acquire the energy from the either the autotrophs or from the heterotrophs, but they are actually not going to utilize the energy in the form of food. They are actually going to directly acquire the energy from these two sources.

So, one of the classical example is most of the disease causing organisms, some form of the fungi, some of the bacteria and all those are actually calling, falling under the parasitic stage. Then the fourth mode of nutrition is called as the chemotrophs. So, chemotrophs are the another class of bacteria. So, chemotrophs are the bacteria which actually not acquiring the energy from the sun, but they are actually acquiring the energy when there is a volcanic disruptions or other kinds of radiation, so, that and that they use to synthesize the compounds and under this category, you have the some of the bacterial species which are actually being found into the ocean.

And so these are the four modes of nutrition, you have the chemotrophs, you have the autotrophs, you have the heterotrophs and then you have the parasitic nutrition. Apart from the, this nutrition can be also be classified whether you are taking the whole food or whether you are taking a part of that.

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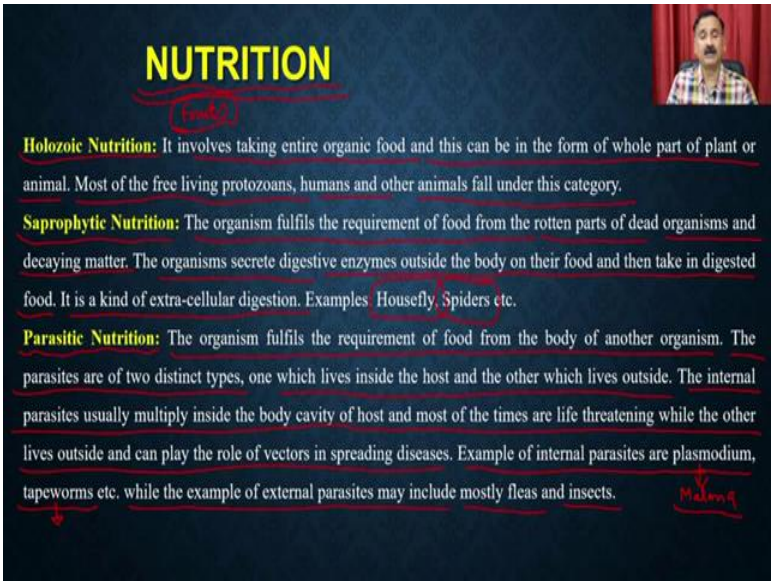

So, nutrition can also be classified as per the type of the food what you are taking. So, you can have the holozoic nutrition. So, it involves taking the entire organic food and this can be formed in the whole part of the plant or the animal. For example, we are taking the fruits. So, we are

taking the fruits as the piece, like you are, if you are eating the apples or if you are eating the grapes or banana or anything, you are eating as a whole. You are not making it as like a space or something so that is called as the holozoic nutrition. Most of the free living protozoans, humans and other animals fall under this category. So, they do not eat the liquid. They eat the raw material or they eat the entire organic food.

Then we have the saprophytic nutrition. So, saprophytic nutrition is the organism fulfill the requirement of food from the rotten part of the dead organisms and the decaying material. The organism secretes the digestive enzyme outside the body on their food and then they take in the ingested digested food.

This kind of extracellular digestion, for example, the houseflies, I am sure you might have seen that the housefly when it sits on your food or when it sits on the rotten material, it actually produces the saliva and that saliva is actually containing the digestive enzymes and that digestive enzyme first digested the food material and then it actually sucks that digested material and that is how it is actually taking up the nutrition.

I am sure you had seen the spider also. Whenever there is a spider web and when there is a insect get trapped into this, the spider is actually goes and then it actually sucks the nutrition. So, it actually use the saliva and other kinds of enzyme and that is how it actually digest the ingested insects or the trapped insects and that is how it actually going to take up the nutrition.

Apart from that we also have the parasitic nutrition. So, organism fulfill the requirement of food from the body of another organisms. The parasites are of two different types, one which lives inside the host and the other which lives outside. The internal parasites usually multiply inside the body, cavity of the host, and most of the times are life threatening, while the other lives outside and can play the role of vectors in spreading the disease.

Examples of the internal parasite are the plasmodium, the parasite which actually causes the disease called malaria, or you can have the tapeworm which actually causes the infection from the inside. And while the example of the external parasite may include the most of the fleas and the insects like the mosquitoes. So they actually suck the blood.

So, that is why their mode of nutrition is saprophytic because they take up the, direct the food material and they also causes the disease. So, you can see that the external parasites are actually going to spread the disease. They are not life threatening. But internal parasites are life threatening, for example, the malaria, TB, the TB is caused by the mycobacterium tuberculosis or all other kinds of bacteria, even the COVID virus and all those kinds of things. So, those are the parasitic nutrition.

Now, when we talk about the nutrition, you also have to understand why the people are taking the organic food and why there is a need and form where the, this energy is stored. So, which actually they utilizes and that is how they are actually looking for the organic material what is being prepared or what is being synthesized by the plants.

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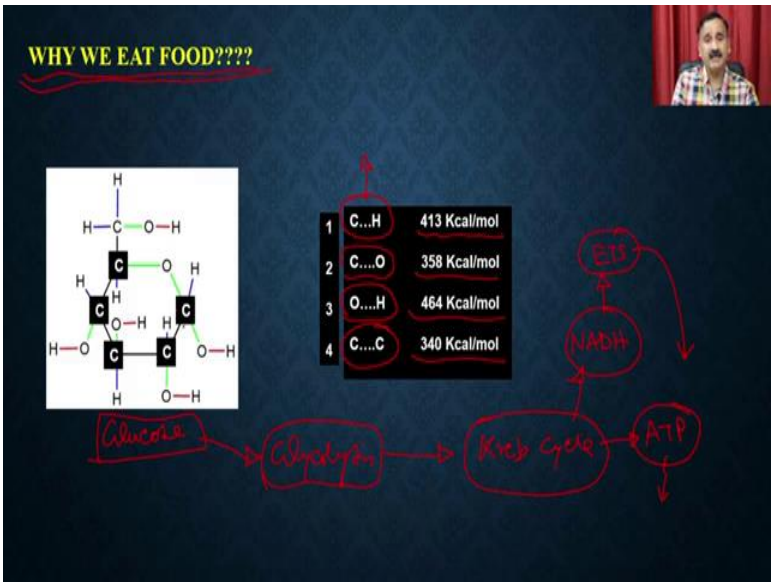

So, let us see that. Now, we have taken a very simple example, which is an example of the glucose where you have the different types of bonds. So, what are the bonds you have, you have a CC bond, you have the CO bond, you have the OH bond and then you have the CO bond. So, what you see here is I have given you a bond energy. So, these are the bond energy what is present in this particular molecule. So, you have a CH bond, which is actually having an energy of 413 kilocalorie per mole, you have the CO bond which is actually having a energy of the 358 kilocalorie per mole, you have a bond of OH and you also have a bond of CC.

So, now, what happened is that what this energy means that if you break this bond, you are at this bond is actually going to release that amount of energy. So, this bond is formed because this amount of energy is being spent. So, if you break this bond, you are actually going to produce the energy. So, these all these bonds are actually carrying up some amount of energy.

So, if you destroy this particular organic molecule which is glucose and if you made it like carbon dioxide or water or something, if you put into the glycolysis which I think we discussed or followed by the Krebs cycle, what will happen is that the energy what is present in this bonds are actually going to be extracted utilizing these pathways and then ultimately what you are going to produce is you are going to produce the reducing equivalent like NADH or you are actually going to trap that energy in the form of ATP and then NADH is go into the electron transport chain and ultimately electron transport chain is also going to produce the ATP.

So, ultimate goal is that you are actually going to acquire the energy what is stored in the form of these bonds and you will be break down this product and you will actually going to acquire the energy. And this is a free form of energy. This is a bound form of energy. This energy cannot be utilized. If you keep a glucose bottle in your home, it is does not contain any energy. But if you put it into your body, it is actually going to be utilized by the these metabolic reactions or these metabolic pathways and that is how it is actually going to produce ATP which is actually a free form of energy.

And that can be utilized for the different types of reactions what is required for muscular transport, that is required for the nervous system, that is required for producing the different types of hormones or protein synthesis, protein catabolism, anabolism and all those kinds of things.

So, this is the purpose why we eat actually food. We eat food because we are looking for these monomeric glucose molecules and that is how we can actually be able to extract the energy what is stored in this molecule in the form of the bonds. Now, let us take an example, what will be the purpose of the digestion. So, why we need to digest these materials?

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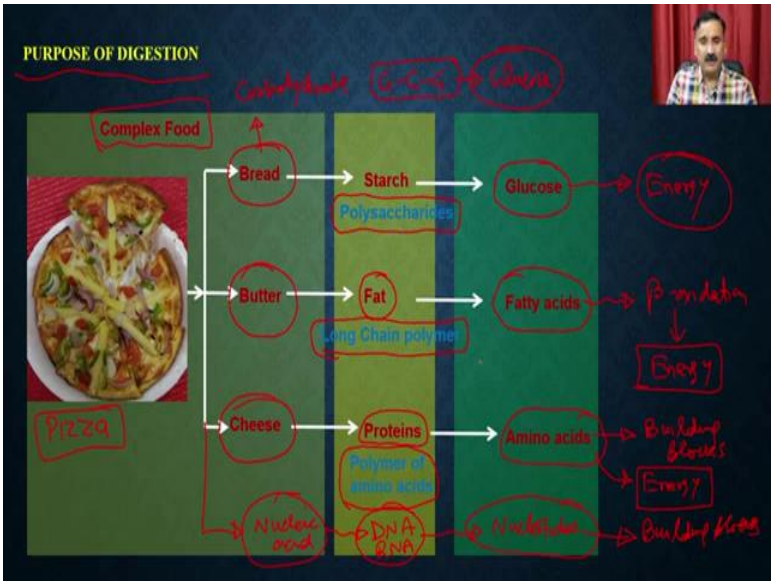

We have taken an example of a pizza. So, if you eat a pizza slice, what you are going to get. So, pizza is a complex food, because it contains different types of food material. And apart from that, pizza is actually a combination of the different types of food material like it has a bread, it is made up of the butter and it is also made up of the cheese. So, these are the three components which are mainly been present. Apart from that you have the different types of toppings like onions, garlic, and you have the capsicum and all that.

Bread, bread is that? Bread is actually a carbohydrate. So, bread is made up off of the starch. So, it is actually a polysaccharide. But polysaccharides are actually having a glucose molecules and glucose polymer cannot be utilized directly so that you can be able to put them under the glycolysis. What you require is you require a individual glucose molecule.

So, you start with a very large chunk of bite which actually going to have the bread, butter and cheese and within the bread, which is actually a starch or the carbohydrate, and the purpose is that from this polysaccharide you actually should be able to extract the glucose and then this glucose can enter into the different types of metabolic reactions and that is how you can be able to produce the energy.

Same is true for the butter. You have the butter. So that butter is nothing but the fat and fat is a long chain polymer and that long chain polymer cannot be utilized. So, the fat has to be

converted into the fatty acid and then the fatty acid will enter into the beta oxidation and that is how it is also going to produce the energy.

Same is true for the cheese. So, cheese is made up of the protein and protein is a polymer of amino acid. The protein what you have in the cheese is probably may not be required into the body. But these amino acids are required, because they are actually going to be the building block. So the protein has to be also get dissected or degraded into the individual amino acids.

And then these individual amino acids can serve two purposes that can be building blocks. So they can be directly get into the body and then you can actually be able to synthesize the new proteins or they can also be utilized as the energy source. In case there is a requirement you can actually be able to oxidize the amino acids and that is how you can be able to produce the energy.

Apart from these three molecules you can also going to have the nucleic acid, because all these food material is actually going to have the nucleic acid. So, nucleic acid means you are going to have the DNA or the RNA and again the same thing DNA and RNA is also going to be the polymer and these polymer cannot be directly been utilized. So, all these polymer has to be converted into the nucleotides and then these nucleotides can be utilized as a building block.

So, what you can see here is the purpose of the digestion is that it actually produce, it actually taken up the complex food and then it converts that into a simpler food, that simpler food can be absorbed by the body and then it can utilize according to the requirement. Glucose can be utilized to produce the energy, the fatty acid can be utilized for producing the energy, whereas these two molecules are mostly being used as a building block rather than the energy source, because you always have a deficiency of the nucleotides and as well as the amino acids, so you always try to use them for producing the different types of proteins.

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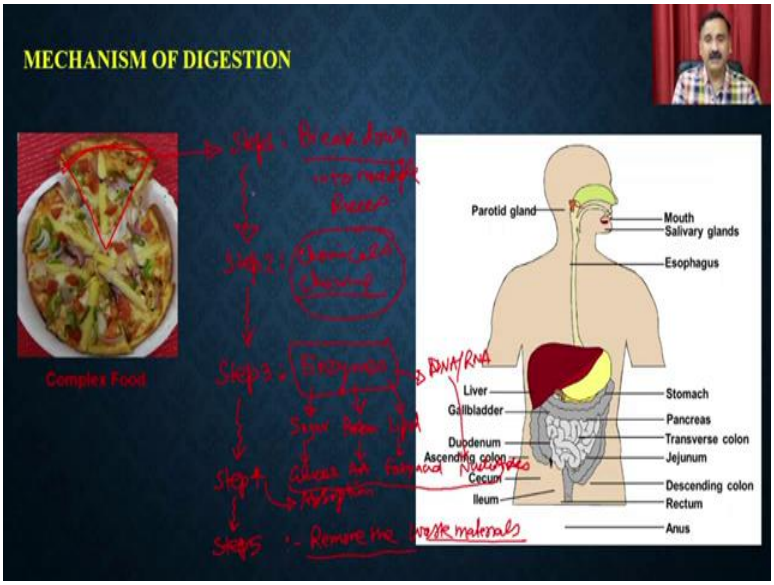

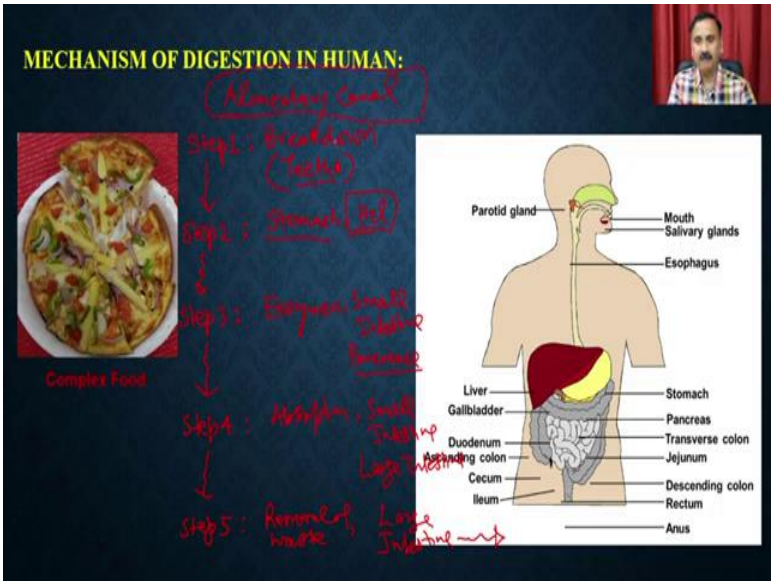

Now, if you try to see what is the mechanism of this digestion, so what you are going to do is first you are going to have a very large chunk of the pizza slice. So, first step, in the step one what you require is you actually should have a machine so that it actually could get break down into multiple pieces. Now, once the, they are going to be break down into the multiple pieces, then you are actually going to add the step two where they are actually going to get separated.

At this stage since they are actually going to be broken into small, small, small piece, then individual piece can be processed and then you are actually going to add some chemicals so that you are actually going to soft the tissue material or soft the food material. You can also have the

physical processes like the churning so that they are also going to mixed with the chemicals. And in the step two, you are actually going to add the chemical so that the individual food material is actually going to be get separated from the these small, small, small pieces.

Then you are going to enter into the step three. In step three, then you are actually going to add the enzymes. These enzymes are actually going to be specific. So, these some of the enzymes are going to be for the sugar. So, they will be actually going to attack on the polysaccharides. Then some of the enzymes are actually going to be attack on the proteins. And then some of the enzymes are actually going to attack on the lipid or the fat. Some of the enzymes are also going to attack on the DNA and as well as the RNA. And that is how in the step three, they are actually going to produce.

Now, in the step four, step four what you have is, once this enzyme will work then the sugar is going to be converted into the glucose, protein is going to be get converted into the amino acids, lipids are going to be get converted into fatty acid and the DNA and RNA is going to be get converted into the nucleotides.

So, in the step four, you are actually going to have the absorption. So, in the step four, you are going to absorb these material. Now, since you are doing, you are running a machine, so you are actually utilizing the different types of chemicals, you are utilizing the different types of physical processes and you are, then you are also utilizing the different types of enzymes you are also going to produce the byproducts.

So, then the step five, step five, you are actually going to remove the byproduct or remove the waste material. So, whatever is not going to be get digested which means if you take the pizza some of the material may not be having the machinery available so that is actually going to be remain unprocessed and that is going to be removed from the body in the form of waste material.

Now, if you see what are the things required. So, in the step one you are actually should have, so what are the things required. Step one, you are actually doing a breakdown. So, for the breakdown you actually require a machinery which is called as teeth. So, you require a machinery which is called as teeth.

In the step, then it enters into the step two. Step two require the treatment with the chemicals and treatment, and then the churning. So that is actually going to happen in the stomach and the enzyme is going to, stomach is going to secrete the HCl and that is how it is actually going to have the chemical digestion of your food and then it will also going to have the churning of that food so that the food is very nicely going to mixed up with the chemicals and then chemicals are actually going to make the substance.

Then in the step three, you are actually going to have the enzymes. So, in step two, you are going to have the enzymes. These enzymes are actually going to secrete from the small intestine and these enzymes are also going to be secreted from the pancreas. Now, in the step four, you are actually going to do the absorption. So, that absorption is also going to happen in the small intestine and is the large intestine.

And then you have the step five. So, step five, you have, actually going to have the removal of the waste that is going to happen in the large intestine. So, large intestine is actually going to produce the waste and that is actually going to be removed from the food. So, this is what you see. This is the alimentary canal. So, this all digestion is going to happen in organ which is called as the alimentary canal. And alimentary canal has the different types of components.

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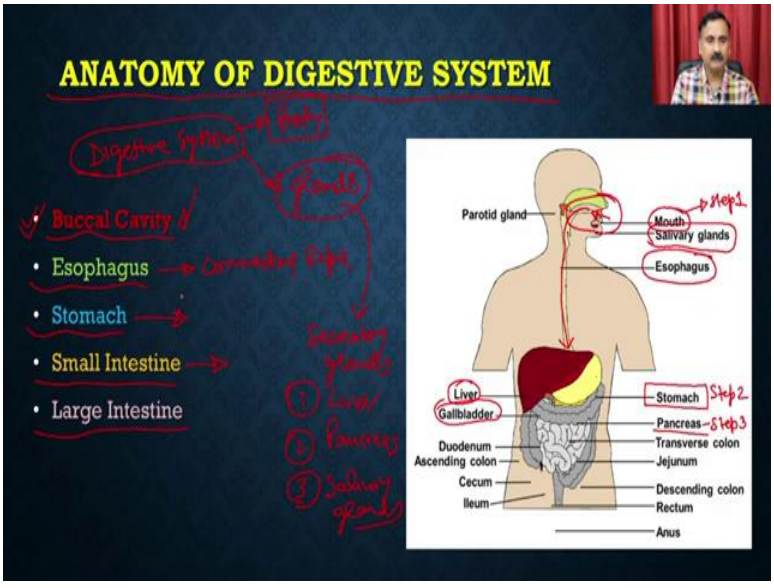

Now, let us see what are the things you have. So, first is you are going to have the mouth and from the mouth you are actually going to take up the food. Once you take up the food then it is

actually going to enter, so enter into the stomach. This pipe what you see is called as the esophagus. So, esophagus is a tube. And then this tube is entering into the another part which is called as the stomach. So, stomach is here. And then the stomach is going to do the step two. This mouth or the salivary glands are actually going to do the step one.

And then you are also going to have the pancreas. So the pancreas is actually going to do the step three, where it is actually going to secrete the different types of enzymes. And then you have the small intestine and as well as the large intestine and that are actually going to do the step four and five. Apart from these you are also going to have the different types of glands like the liver, gall bladders, you also have the pancreas and then the you have the many of the enzyme in the mouth which are called as the salivary glands and other things.

So, if you divide the elementary canal or if you divide the digestive system, you are actually going to have the two parts, one is you are actually going to have the body or the anatomy of the body which are actually going to participate and then you also have the different types of glands which are also going to participate into the digestion. So, when we are going to discuss about the anatomy of the digestive enzyme, what we are going to discuss, we are going to discuss about the buccal cavity.

So, this is the place what you see here is called as a buccal cavity, where you have the mouth, you have the teeth, you have the salivary glands and all other kinds of things. Then we have the esophagus which is actually a connecting tube or connecting pipe between the mouth, buccal cavity and the stomach. And then you have the stomach which is actually going to be a belly like structure and where the food is actually first time is going to be stored. And then you have the small intestine. The small intestine is a major place where you are going to have the major digestions and then you have the large intestine.

Apart from that you are also going to have the different types of secretory glands. You have the secretory glands like you have the liver, you are actually going to have the pancreas and you are also going to have the salivary glands. So, what we are going to discuss, we are going to first going to discuss about the anatomy of the organs and then we are also going to discuss about the anatomy of the glands. So, let us start with the buccal cavity.

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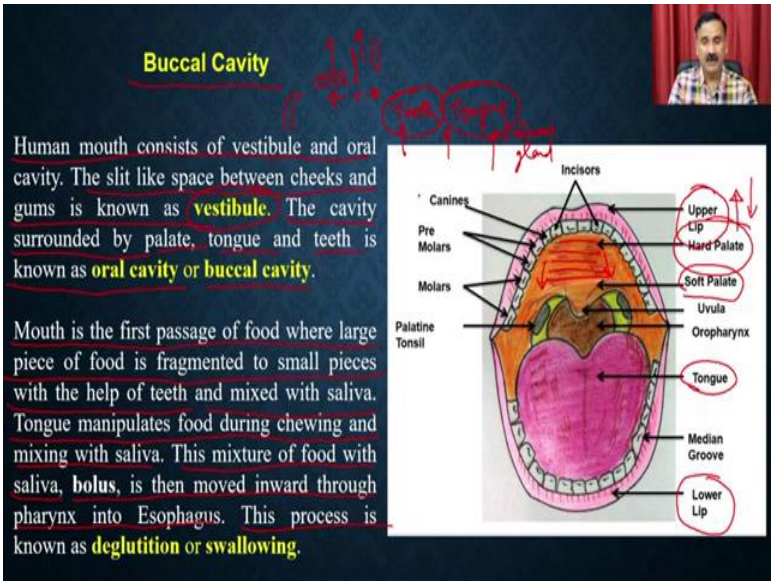

Buccal cavity, so buccal cavity is, this is the buccal cavity what you see here. The things you have, you have the teeth, you have the, and the buccal cavity is actually going to be divided into the multiple components. So, you have the tongue, you have the upper lips, you are going to have the upper lips and the lower lips, then you have the soft palate and the hard palate, so these are the, and then you also have the teeth. You are going to have the different types of teeth, like the moral, canine, premolar, molars and all that.

So, the mouth, human mouth consists of the vestibule and the oral cavity. The slit like space between the cheek and the gum is known as the vestibule. So, what you see here is the space next to your teeth but outside within the lip is called as the vestibule. The cavity surrounded by the palate, tongue and teeth is actually been known as the oral cavity or the buccal cavity. So the cavity what you see behind your teeth and below up to the palate is actually going to be called as the oral cavity or the buccal cavity.

So, you can imagine if you have a teeth here and you have a lips here, this is the cavity which is called as the vestibule and this is the cavity, and this is suppose here you have the esophagus, so this is the cavity what is called as the buccal cavity. So, this is the teeth and on the backside of the teeth you have the buccal cavity, on the front side of the teeth but before the lips are called as the vestibule.

Mouth is the first passage of food where the large piece of the food is fragmented into the small pieces with the help of the teeth and mixing with the saliva. Tongue manipulates the food during the chewing and mixing with the saliva. This mixing of food with the saliva or bolus is then moved inwards through a pharynx into the esophagus. This process is known as the degluting or the swallowing.

So what happened is that salivary glands are actually going to secrete the saliva and then these salivas are actually going to be mixed up by the movement of the tongue. So, when you eat you actually are actually going to use the tongue so that tongue is actually going to place the food particles below the different types of teeth and that is how the teeth are actually going to have the churning processes or crushing and all those kinds of things. So, those kinds of events are actually going to process.

Apart from that you what you see here is you have actually going to have that two different types of palate. You are going to have the soft palate which is on the backside and then you also have the hard palate. This hard palate, which you actually can easily experience when you actually touch your top roof of your mouth these are actually having the ridges and these hard palate is always throwing the food on the front side. So, if it is not there, if it is actually, hard palate is not there, then when, while you are chewing the food may actually can fall outside, because the hard palate is always pushing the food on the backside though that the food will always be coming below the teeth and it will should not be come out.

And when the saliva is mixing with the food, it is actually going to make a bolus and that bolus and this, and that bolus is only going to enter into the stomach through the esophagus but and this process of swallowing, this process is known as the swallowing. Now, within the buccal cavity you have the major component like you have the teeth, you have the tongue and you also have the different types of salivary glands. So, let us discuss about the teeth and the tongue and then we are also going to discuss about the salivary glands.

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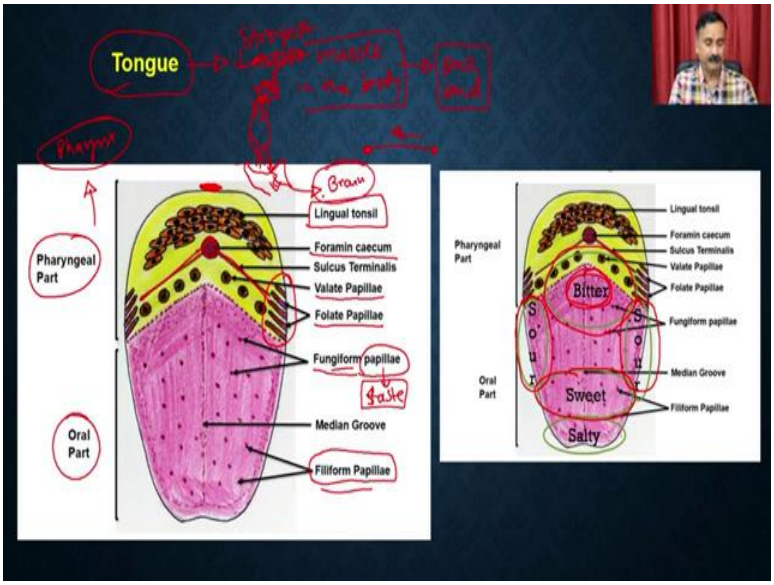

So, let us start with the tongue. So, tongue is actually a part, is a strongest muscles in the body and this is the only muscle which is attached from the one end. Most of the muscles what you are going to see in your body are actually been enacted on the both side because their job is to help in the contraction. So, they are actually been connected.

For example, if you see the biceps they are connected on this side and then they are connected on this side and that is why with the help of the biceps you can be able to pull your arm or you can be able to pull your the heavy loads actually. Same is true for the different types of muscles what is there in your legs or the ribs and all other places. But tongue is a muscle which actually been connected only on one side. So, it is a site from where it is going to be connected.

So, if you see the anatomically, the tongue is going to be divided into two parts one is called as the pharyngeal part, this is the part which is actually going to be towards the esophagus or towards the pharynx, so this is this part is towards the pharynx, and then we have the other part which is called as the oral part. So, from this side, it is actually going to be connected towards the pharynx. Now, if you see the tongue, it actually has the different types of papillae. So, these papillaes are actually going to be having a function of sensing the different types of tastes. So, they are actually being used for tasting the different types of tastes.

You can have the different types of papillaes, like you can have the valate papillaes, you can have the folate papillaes, you can have the fungiform papillaes and then you also have the

filiform papillaes. All these papillaes are having a major function that they are actually going to give you the information about the different types of tastes.

They are different because their anatomy is different, because most of the papillaes are actually having a bell shaped shape. And within this, this portion is connected to the internal cellular structures or cellular machinery. And when they are actually going to sense any food or any food material when enters into this, it actually causes a sensation and these sensations are then to be carried out towards the brain and that is how it is actually going to give you the senses.

Apart from that, there is a structure which is called as the foramen caecum and that foramen caecum is the place which actually divides the tongue into the two parts. On the top side you have the lingual tonsils. These lingual tonsils are actually the part of the lymphatic system. They are sometime gets swelled and that is how you are actually going to have the different types of tonsil related problems. On this side you have the lingual tonsils and on this side you have the sulcus terminalis. So, this sulcus terminalis is actually going to divide the tongue into the two part.

Now, talking about these different types of papillaes, you have the papillaes on the side which are called as the folate papillaes or you also can have the papillaes which are along the axis of this sulcus terminalis and these are called as valate papillaes and then you have the papillaes which are distributed throughout the tongue which is called as the fungiform papillaes and then you also have the filiform papillaes which are also being distributed.

Now, as far as the taste is concerned, this is the portion or these are the papillaes which are actually been responsible for the bitter taste. Then the side of this tongue are actually been responsible for the sour taste. And then the only the tip of the tongue is actually been responsible for the salt, whereas the middle portion of the tongue is responsible for the sweet. So, these are the four areas which are responsible for the providing the different types of taste.

You can have the bitter taste from the backside of the tongue. You can also have the sour from the side of the tongue, can have the salty from the tip of the tongue, like this portion. And then you can also have the sweet in the center of the taste. So, that is why this actually, if you know this information you can easily be able to utilize that information and you can be able to enhance the particular taste. For example, if you want to eat the chili, but you do not want to taste it, you

can actually be able to somehow avoid that the chili part should not be hit this particular portion. So, then if you does not hit this particular portion, it, actually you are not going to have the senses.

And how the census works, actually, I already explained you, whenever there is a food material, it is actually going to be presented as a small food particle. So that that food particle will go and bind to these food taste buds, and then these taste buds are actually going to receive this and they are actually going to get sensitized and they will send a signal downstream, and these downstream signals are going to be received by the cell and that cell is actually going to send this signal through the nervous system to the brain and that is how you are actually going to receive the or you are going to sense the taste. Now, we are talking about the another part which is called as the teeth.

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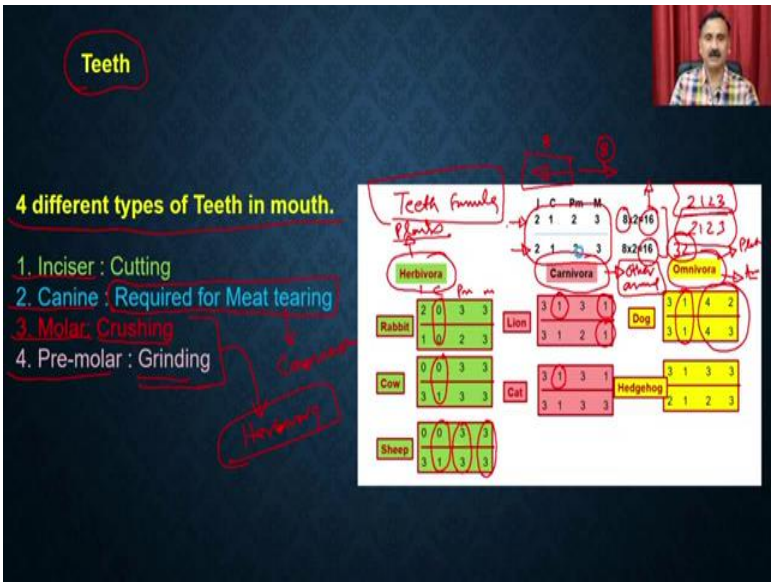

So, teeth, we have the four different types of teeth in the mouth. We have the incisors, we have the canines, we have the molars, and we have the pre-molars. Now, the canine is required for the meat tearing or it is actually been required for the meat. So, that is why the canines are mostly been found in the carnivore, and whereas the molar and the pre-molars are mostly been required for the crushing and grinding, and that is why they are more prominent in the herbivore.

So, what you see here is I have given you, so the distribution of these four type of teeth in a mouth, if you write that in the form of a systematic formula that is called as the teeth formula or

it is called as the teeth formula. So, in the teeth formula what you are going to write is you are going to write the incisors, canines, pre-molars and molar. So these are the top row and these are the bottom row. So this is the top jaw, upper jaw, this is the lower jaw. So what you see here is that I have given you this as the teeth formula for the humans. So, you have the two canines, two incisors, one canines, two pre-molars and three molars. This is the top row. So this is the front half. This is the, on this side.

Then it is on the lower side. It says that 2, 1, 2, 3. So, it is going to be called as 2, 1, 2, 3 by 2, 1, 2, 3. So how you are going to calculate the number of teeth, so this is the half of the mouth, half of the jaw actually it is same. So, on this half, you are actually having 2, 1, 2, 3, so this is number 8. So, on this side you have 8, on this side you have the 8 that is why the total is 16. So, 16 in the upper jaw and the 16 in the lower jaw and that is why the humans are actually going to have the total 32 teeths.

Same is true like what you see here is these are the teeth formula for the herbivore, these are the teeth formula for the carnivore and these are the teeth formula for the omnivore. Herbivore are the organisms or the animals which are only eating the plants. So, there they should have the more amount of molars and the pre-molar, because they required to crush the plant material and all that. So, what you see here is a rabbit. So, rabbit is 2, 0, 3, 3, which means this is the pre-molar, this is the molar, this is the incisor and can I see the canines are absent. Canines are completely absent. Canines are absent. And you have the large number of molars and the pre-molars.

So, same is true like even if you have the carnivores, the carnivores are actually going to have the food from the other animals. So they are actually going to have the, they are going to kill the other animal. So, see here, this is the teeth formula for the lion, so it has 3, 1, 3, 1. So, you have one in canines, so you have one canine and there is a very small amount of molars, so that is why because they do not require this. They do not require the molar and pre-molars.

Whereas in the omnivores, omnivores are the organism or the animals which are actually going to take up the nutrition both from the herbivores and as well as from the carnivores. So, they can actually take up the nutrition from the plant or they can also be able to take up the nutrition from the other animals. In this one the both type of teeths are actually going to be developed. So, what

you see here is it also has the canines and they also have the molars and as well as the pre-molars. So, humans are actually been fall under the omnivores and that is why they also have the well developed molars and pre-molar and as well as they also have the canines.

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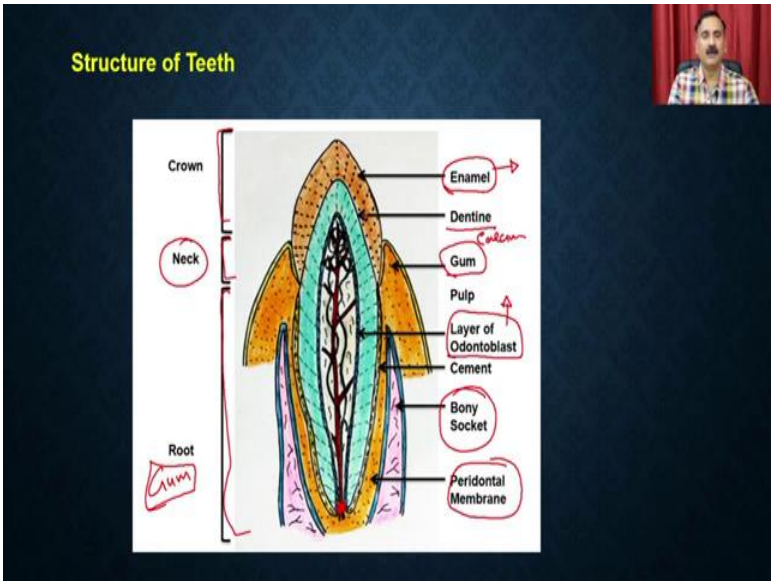

Now, if you see the structure of a teeth, so a structure of a teeth has the three components. It has a crown, it has the neck and it has also has a root. This root part is present inside the gum. This is present inside the gum. The neck portion is actually the portion which is just comes out. And the crown is the portion which actually you see actually outside. The crown is being covered with a thin layer of the shiny coating and that is called as the enamel.

Then you also, the teeth is also been formed by the bony base which is called as the dentine and then the dentine is present inside the gum and dentine is having the supply of the blood from inside and that is how it also has the pulp and all other kinds of things. So, teeth can actually be able to grow for lifelong as long as until and unless this particular cavity is not been closed. So some of the teeths which they actually acquired the maturation, then this particular portion is going to be filled and then this portion is going to die and it will get the food material and the calcification and that is how, so this layer is actually made up of the dentine and it also has the calcium.

Then you actually having a layer of the odontoblast and odontoblast are actually going to secrete the dentine and that is how they are actually going to make the teeth. Then you have the bony

socket or the jaw bone in which the teeth is actually going to be present. And then next to that you also have the periodontal membrane. So, in the teeth the enamel which is actually the hardest material and it is actually gives the protection to the lower teeth and that is how the teeth is actually going to be utilized for different types of purposes.

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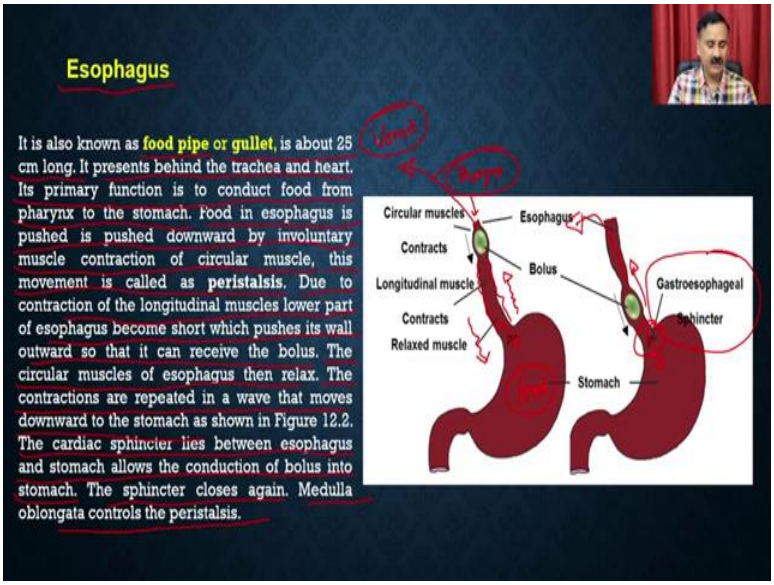

Now, let us move on to the next anatomical structure and the next anatomical structure is called as the esophagus. So, esophagus is also known as the food pipe or the gullet and it is about the 20 centimeter, 25 centimeter long. It present behind the trachea and the heart. It is primarily function is to conduct the food from the pharynx to the stomach.

So its main function is that it should receive the food from the pharynx. So, it is going to receive the food from the pharynx. Pharynx is the backside of the buccal cavity. And then it should give you the food to the stomach. The food in the esophagus is pushed downward by the involuntary muscle contraction of the circular muscle. This moment is called as peristalsis.

So, the muscles what is there in the esophagus is actually doing a peristaltic movement that is how the, they are actually going to push the food into the stomach and this moment is called as the peristalsis. You might have seen that some of the kids actually, they actually vomit out the food. So, why they vomit out, because the peristaltic moment is actually running in the wrong direction.

So, when they sometime they actually have the food which is getting trapped into their food pipe then they actually have the peristaltic movement in the wrong direction. Normally the peristaltic movement should be in this direction so that the food what you take is go into the stomach. But if the peristaltic movement would be in the reverse direction then the food will go out of the mouth and that is how you are actually going to say that the kid has vomited the food.

Sometimes the vomiting also can happen even from the food material what is there in the stomach also. So, from the, if there is a reverse peristaltic movement, then the food can also be able to come even from the stomach also. Due to the contraction of the longitudinal muscles lower part of the esophagus becomes short which pushes its wall outward so that it can receive the bolus. The circular muscles of the esophagus then relax. The contractions are repeated in a wave that moves downward to the stomach. The cardiac sphincter lies between the esophagus and the stomach allows the conduction of a bolus into the stomach. This sphincter closes again. The medulla oblongata control the peristalsis.

So, you have the sphincter here which actually controls the flow of the food. So, it can actually only can go towards this side. But if there will be an error in the sphincter and if there will be a food and if there is a reverse peristaltic moment, then the food material can also be able to come out from the mouth in the form of a vomiting.

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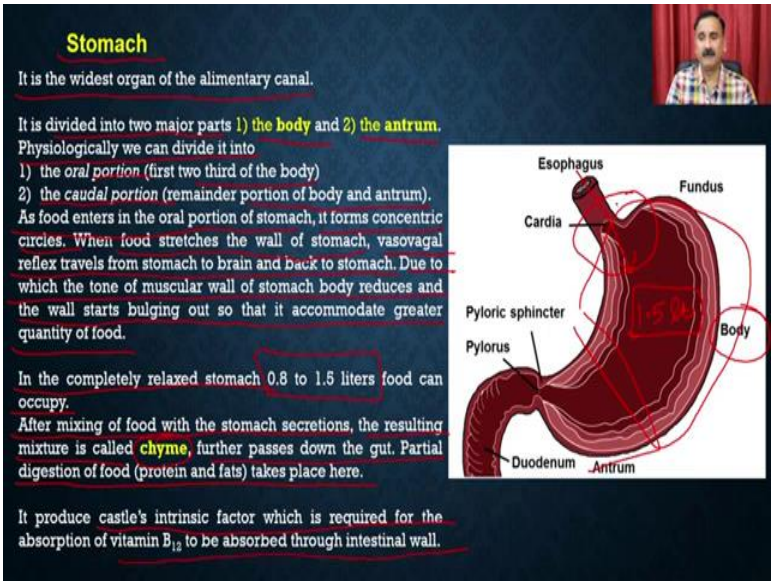

Now, let us talk about the stomach. So, it is the widest organ of the elementary canal. It is divided into two major parts such as the body and the antrum. Physiologically we can divide it into the oral portion, the first two-third of the body, so this is the portion, so first two-third of the body. So, this is, here you can actually be able to divide the stomach into the two part; one, the body, this is the body which actually has the major chunk; and then you also have the antrum which is actually the ending of the portion. So, this is the body and this is the antrum.

Physiologically, you can divide that into the oral portion. So, this is the oral portion what you have and which is actually going to be two-third of the body and the caudal portion which is the remain portion of the body and so this portion is called as the caudal portion and this portion is called as the oral portion. As the food enters into the oral portion of the stomach it forms the concentric circles. When the food stretches the wall of the stomach, the vasovagal reflex travel from the stomach to brain and back to stomach due to which the tone of the muscular wall of stomach body reduces and the wall starts bulging out so that it accommodates the greater quantity of the food.

So, when you are taking up the food the stomach is of very small size. But as you keep taking the food more and more the stomach walls are flexible, so they can actually be able to expand and they can be able to expand to accommodate the large quantity of the food. In the completely relaxed food, relaxed stomach, 0.8 to 1.5 liter food can occupy. So, you, if the stomach is completely empty and it can actually be able to relax, it can actually take up approximately 1.5 liters of the food.

After mixing of the food with the stomach secretions, the resulting mixture is called as the chyme, further pass down the gut. The partial digestion of the food such as the protein and as well as the fat actually take place within the stomach. It produces the castle's intrinsic factor which is required for the absorption of vitamin B-12 to absorb through the intestinal walls.

So far what we have discussed about the anatomy of the elementary canal. What we have discussed so far, we have discussed about the buccal cavity and we have discussed about the esophagus and we also discussed about the stomach. In our subsequent lecture, we are also going to discuss some more aspects related to the anatomy of the elementary canal where we are going

to discuss about the small intestine, large intestine and then we also going to discuss about the different types of glands. So, with this, I would like to conclude my lecture here. Thank you.