Thermal Processing of Foods
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Lecture No. 26
Types of Functional Foods: Probiotic and Nutraceuticals

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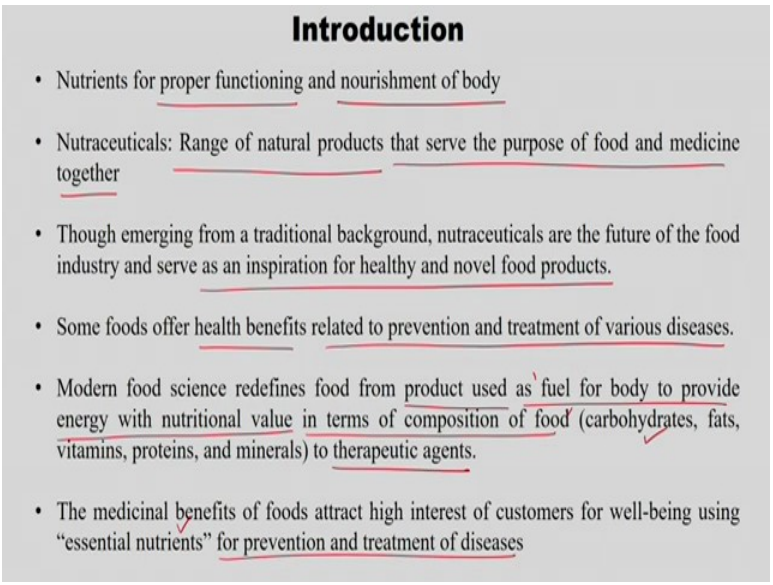

Good morning everybody, so last class we have seen about the biosensors. So today's class we are going to discuss about the types of functional foods so in that probiotic as well as nutraceuticals. So we know the food is nothing but a basic requirement of any human life and that food contains many nutrients so that are very much important for proper functioning as well as nourishment of the body and if you see nowadays there are many diseases so which stressing various body organs from liver to kidney and sometimes it go to the mutations into cancer cells as well. So and other side if you see the treatment becomes very expensive so that is where to compensate this between the diseases and how to treat them naturally, so that is where this particular notion is coined where let food be the medicine and medicine be the food.

So if you see in the ancient history the mostly Indians and Chinese where almost stick to this particular notion. So they were taking food as almost with the all therapeutic values and also the same thing was there for Athens and Comedian as well, so infact the context whatever we are going to talk about today which is nothing but an nutraceuticals, so this particular market if you see the genesis of this nutraceuticals markets it is from Japan. So it is in early 1980 it is started picked up so from there every country started thinking about how the nutrients and

pharmaceuticals can be combine together and how the medicine can be natural instead of chemically synthesis.

So, that is where this particular name is coined which is nothing but a nutraceutical, so nutraceuticals are range of natural products that serves the purpose of food and medicine together, though emerging from a traditional background as I said earlier nutraceuticals are the future of the food industry and serve as an inspiration for health and novel for products healthy and novel food products and some foods offer health benefits related to prevention and treatment of various diseases. So, this is nothing but prevention itself as well as after the diseases come then the treatment purpose as well many food varieties are used and modern food science redefines food, earlier the food is defined as the product used as a fuel for body to provide energy with nutritional value in terms of its composition.

So, food generally contains the composition of carbohydrates, fats, vitamins, proteins and minerals, so this is the earlier the definition, definition is nothing but a its nothing but a food is nothing but a fuel for body to provide energy and nutritional value by its composition as well but that is changed from not only fuel for the body sometimes it is also used as a therapeutic agents. The medicinal benefits of foods attract high interest of customers for wellbeing using essential nutrients for prevention and treatment of diseases, so more than normal food the foods with particular essential nutrition, so that got attracted in the food market by the consumers.

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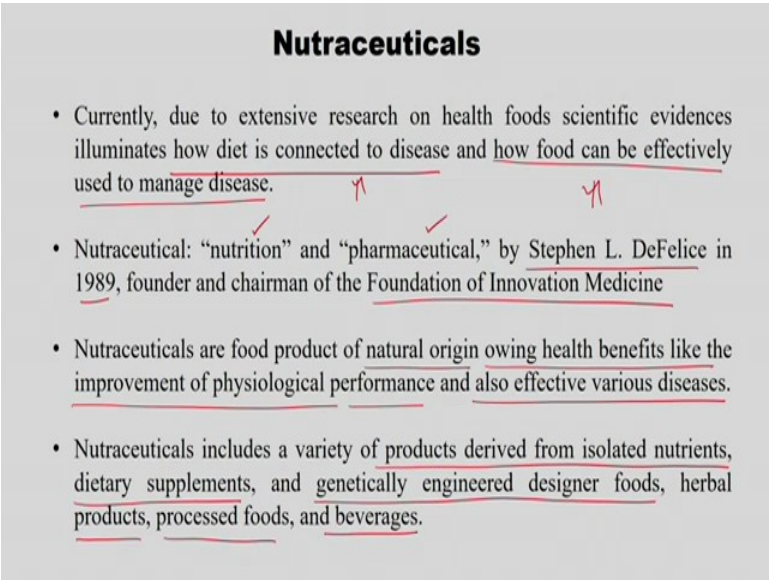

The currently due to extensive research on health foods, scientific evidences illuminate how diet is connected to disease and how food can be effectively used to manage diseases, so that is where the current research trend. So, you may be thinking about why in the thermal processing of food we need to talk about the nutraceuticals and infact last class we discuss about the food biosensors but as I said earlier during the thermal processing due to high temperature most of the nutrient quality we lose, in one of the lectures we also discuss that can be added later maybe mostly the volatile components are the essential nutrients and sometimes the flavoring agents can be added after the processing.

So that is where we are here to discuss about what are all the nutraceuticals in such cases not only the nutrient quality if I can add something extra which is also having therapeutic agents that would be extra benefit for me. So that is where we are discussing about the all the functional foods and what are all the components present in the functional and dietary supplements and their related therapeutic values we are going to discuss.

So, the current research trend is how diet is connected to disease as well as how food can be effectively used to manage the diseases, so the nutraceutical came from the word nutrition as well as pharmaceuticals this is first coined by Stephen L. DeFelice in 1989 founder and chairman of the Foundation of Innovation Medicine. The nutraceuticals are food products of natural origin owing health benefits like the improvement of physiological performance and also effective on various diseases, nutraceutical includes the products derived from the isolated nutrients, dietary supplements, genetically engineered designer foods, herbal products, processed foods and beverages everything comes under the category of nutraceuticals.

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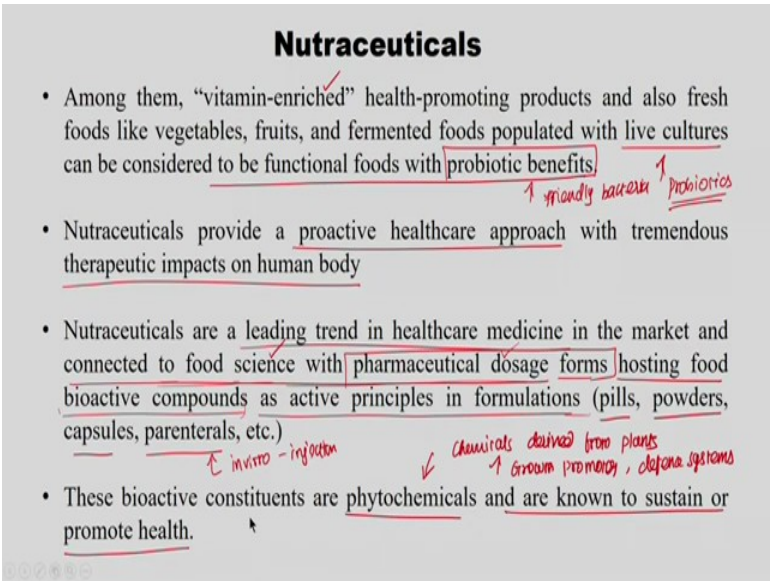

Among them vitamin enriched, vitamin enriched health promoting products and also fresh foods like vegetables, fruits and fermented foods populated with live cultures, so this we call it as probiotics, so these are friendly bacterias so among this verity of products derived from isolated nutrients, dietary supplements and genetically engineered designer foods, herbal products and processed foods. The vitamin enriched health promoting products and also the fresh foods like vegetables, fruits and fermented foods populated with live cultures, probiotic so this is enriched by live cultures can be considered to be the functional foods with probiotic benefits, so this is what we told probiotic benefits so these are friendly bacterias which helps in many metabolic processes in the human body, friendly bacteria.

So, the nutraceutical provides a proactive healthcare approach with the tremendous therapeutic impacts on human body and they are also a leading trend in healthcare medicine in the market and connected to food science with pharmaceuticals dosage forms hosting food bioactive compounds as a active principle in formulations, so nutraceuticals is not only the food science department, it also includes the pharmaceutical dosage forms, dosage forms in the sense either in terms of pills, powders, capsules and parenterals, parenterals are nothing but the invitro, invitro is nothing but a injection form.

So, nutraceuticals are connected to food science with a pharmaceuticals dosage forms in the pharmaceutical dosage forms in the sense this pills, powders, capsules and parenterals which are containing bioactive compounds as a active principle formulation, so normally in pills for example normal diseases if you take pill so that contains particular chemical so which treats as a for example antibody, so that particular pill has a chemical that treats a particular

diseases but here in this pills that nutraceuticals pills you will have a bioactive components as a active formulation.

These bioactive constituents are phytochemicals and are known to sustain or promote health, so phytochemicals are nothing but a chemicals derived from plants, so these chemicals are available in the plants as a growth promoter, so or it sometimes also function as a defense system, it protects the plants from insects and all, so these bioactive components which are used as a dosage form, so these bioactive constituents are phytochemicals and are known to sustain and or promote health.

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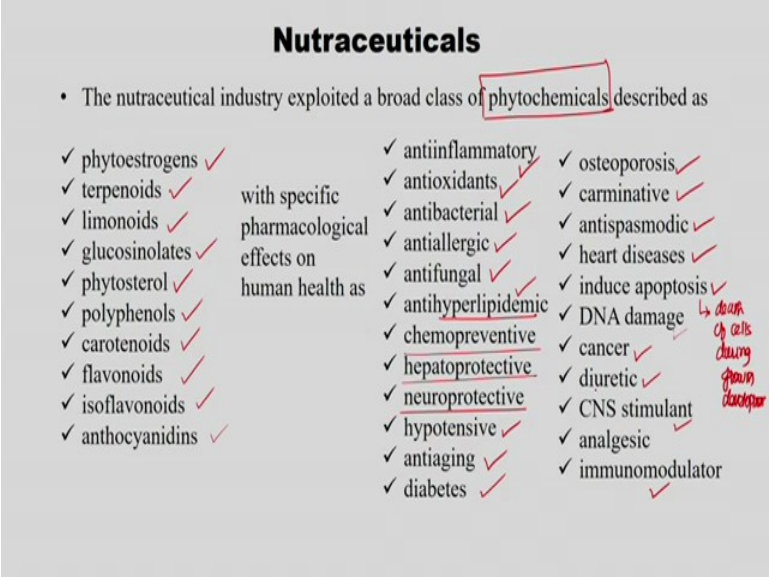

So, the nutraceutical industry exploited a broad class of phytochemical, so mostly the nutraceutical components are bioactive components which are derived from the plants, so they are nothing but a phytochemicals. So what are all they phytoestrogens, terpenoids, limonoids, glucosesinolates, phytosterol, polyphenols, carotenoids, flavonoids, isoflavonoids, and anthoeyanidins. So, with the specific pharmacological effects on human health so those where anti-inflammatory, antioxidants, anti-inflammatory you know which is against the inflammation action of the body and antioxidants which reduces the oxidation which further produces the reactive oxygen species, so these antioxidants stops the or prevent the oxidation reaction so in order to stop the reactive oxygen species protection.

Antibacterial you know against the bacteria anti-allergic and anti-fungal and anti-hyperlipidemic, so that means hypo cholesterol, so anti hyperlipidemic agent means so that reduces the cholesterol then chemopreventive so can against the cancer, then

hepatoprotective, so that is against the liver diseases and neuro protective against the neutral system diseases hypotensive, so hypotensive against the hypotensive so these phytochemical acts as a anti-hypertensive, so that means so to reduce the hyper tension this can be used and anti-aging, diabetes and osteoporosis so this is nothing but a brittle bones and carminative.

Carminative is nothing but anti-flatulence, so that means the air built up in the JI track so this can acts against that and anti-spasmodic the anti-spasmodic in the sense to relive the spasm, so that is nothing but a involuntary muscle contraction, so anti-spasmodic in the sense it reduces the muscle contraction, then it also acts as against the heart diseases and induces apoptosis, so apoptosis is means apoptosis means it is nothing but a death of cells during growth development. So, apoptosis means death of cells during growth development so these phytochemicals induces that so for as a growth promoter and it acts as against the DNA damage and cancer and diuretic so this can be given as a water pills and CNS stimulants CNS is central nervous system and analgesic agents and immunomodulator, so your phytochemicals can act in therapeutic values in many of this categories.

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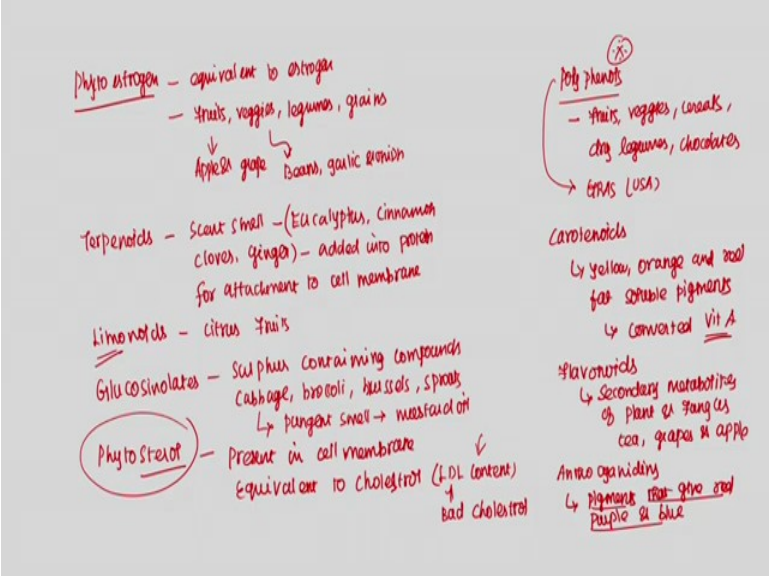

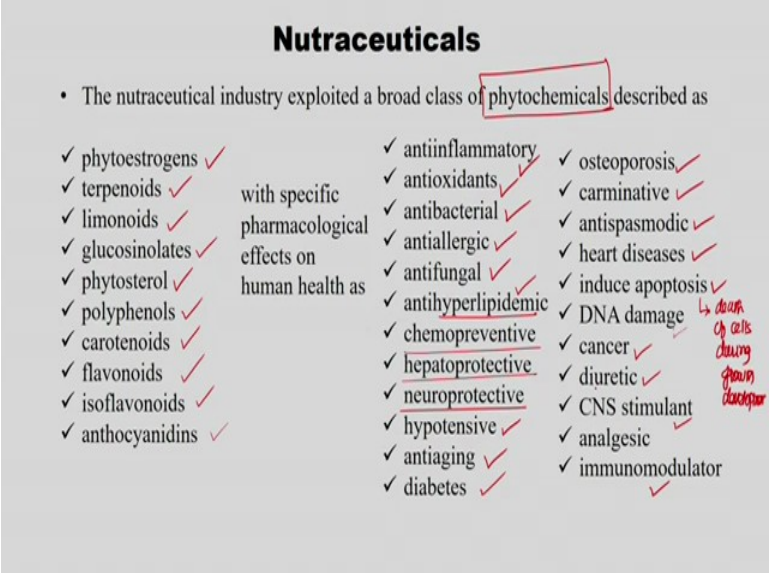

So maybe we can quickly see about, so what are these phytochemicals the first one what we told is phytoestrogen so the name itself you can see here so this is analogous to or equivalent to estrogen so this is found in fruits, veggies, then legumes and grains so major food varieties are apple and grape, so veggies part beans, garlic, onion, garlic and onion. So then next one is terpenoids so these are kinds of scent smells you will get what you get, so this you can find it from Eucalyptus, Eucalyptus tree and in our kitchen you can find it in cinnamon, cloves, ginger etcetera. So when these are added into protein, when these are added into protein for attachment to cell membrane.

So, the next one is Limonoids. So from the name itself you can say so this mostly available in citrus fruits and the next one is glucosinoculate so these are sulphur containing components, sulphur containing compounds, so which are present in cabbage, broccoli, then brussels, sprouts etcetera, actually it is that pungent smell so what do you get that is when you are chewing, so it releases the mustard oil so that is where we sometimes feel little bitter as well. And next one is phytosterol so this is present in this cell membrane, so sterol so it is equivalent to cholesterol and also there are scientific evidences so that it reduces the LDL content in the human body.

So LDL is nothing but a bad cholesterol we say so it reduces when it is taken at a particular dosage. So, the next one is polyphenols, so polyphenols are present in fruits, veggies, cereals and dry legumes and also these are very important chemical very important phyto chemical and some of the polyphenols also got this GRAS tag by U.S.A so this GRAS is in the sense generally regarded as safe and also it is also found in chocolates what we eat, chocolates. So, the next one is carotenoids, carotene you already know because these are pigments so yellow,

orange and red fat, red fat soluble pigments and also it is converted by body as a vitamin A so that is what carrot what you take so that is that is having carotenoids. So which is of yellow pigment and the next one is flavonoids. So they are secondary metabolites of plant and fungus, so they are present in tea, grapes and apple etcetera. So then isoflavonoids is comes under the category of flavonoids then Anthocyanidines, Anthocyanidines so these are pigments that give red, purple and blue colour, so they are pigments which gives red, purple and blue. So that is all about that quick review about these phytochemicals so these are having all these affects.

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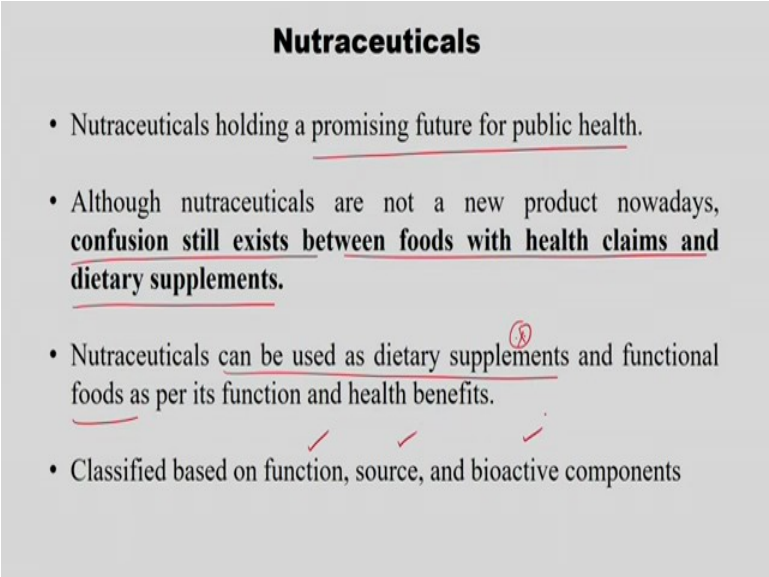

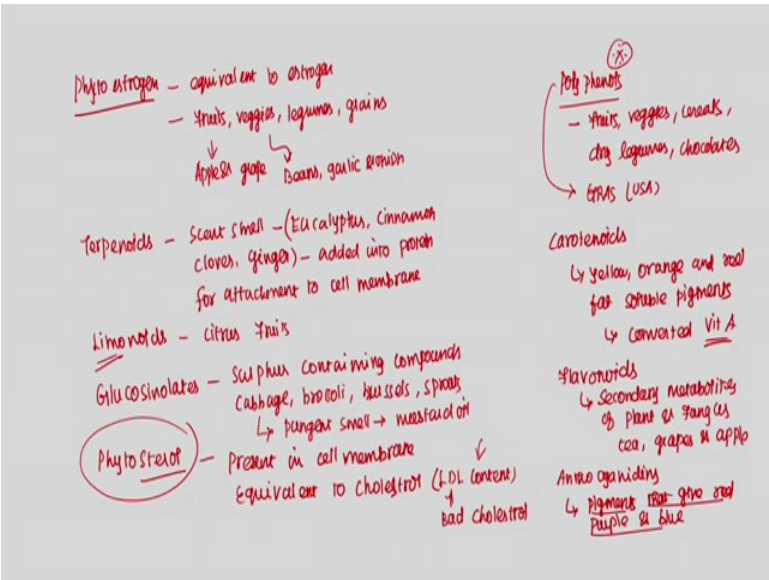

So, nutraceuticals holding a promising future for public health because after seeing that we must be knowing how important these nutraceuticals are, so although nutraceuticals are not a

new product nowadays, confusion still exist between foods with health claims and dietary supplements. For example, here I have told you, so the phytosterol helps in reducing the LDL content, so there are scientific evidence but that cannot be taken as for granted so normally it should be tested on human body properly then those reports we would always depend on to make any claim that this particular phytochemical is having this particular therapeutic effect on human body.

So that one has to be very much careful and whatever we discuss here also it is taken from the particular references and in that reference book if you go and see there are search articles in against the every claim, so in this particular lecture I specially request you to check these facts from the research articles because any clime make here should have proper scientific evidence. We also know from ancient history so certain natural plants and the product were used for therapeutic values but since science also grown up to a particular level so we would be able to check those facts those sayings what we were told by scientific evidences, so that I want you to be bit careful about. So that is where here it is told so the confusions still exist between the foods with health claims and dietary supplements and the nutraceutical can be used as a dietary supplement and as a functional food so these are all major category as per it function and health benefits they are classified based on the function, based on source, based on the bioactive components.

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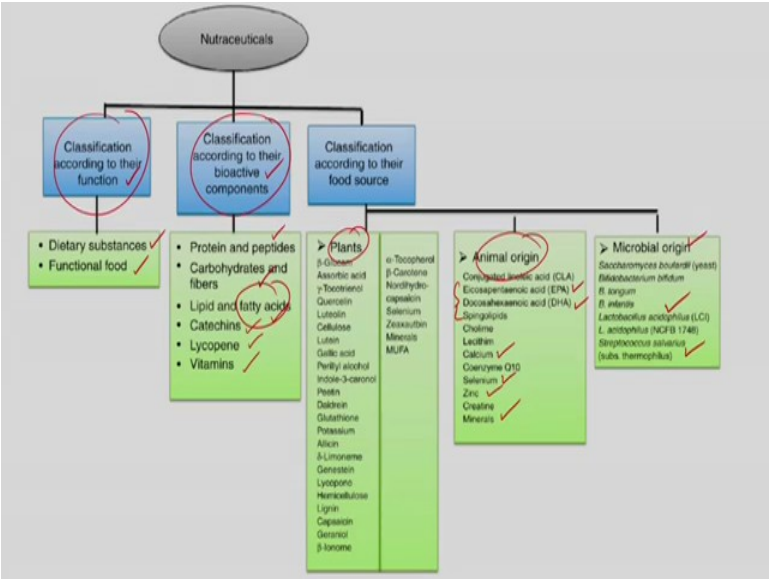

So based on the function they are classified as a dietary substances and functional foods based on bioactive components so whatever we have seen the protein peptides, carbohydrates and fibers, lipids and fatty acids, catechins, lycopene, vitamins and based on their source

from plant, so from plant we have seen many phytochemicals and from animal origin also, I would like to highlight few may be calcium, zinc these are there in the milk itself and selenium, minerals and these two EPA and DHA these are omega 3 fatty acids mostly in the fish.

So they are Eicospentaenoic acid and Docosahexaenoic acid so the EPA DHA and from microbial origin one is from Saccharomyces boulardii and Bifidobacterium bifidum and Lactobacillus acidophilus this is very famous and Streptococcus salivarius, so these are form microbial origin animal origin we already know from fish from cow and plants are most of them are phytochemicals that we have seen earlier bit elaborate also. So in this lecture we are going to only concentrate on based on the function and based on the bioactive components and based on their source in between we will see for example these two omega 3 fatty acids we are going to see in a way in the class of fatty acids and for phytochemicals I have already discusses here, so we are going to discuss in detail about the classification based on function and classification based on bioactive components.

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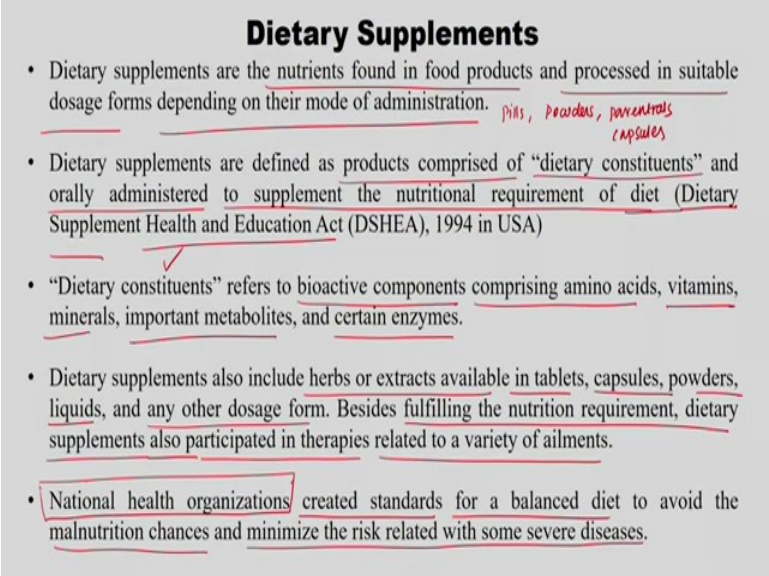

The first one is Dietary supplements based on function so these are nutrients found and food products and processed in suitable dosage forms depending on their mode of administration either it can be a pills, powders and the parenterals and capsules as well, and from the dietary supplement health and education act which is nothing but DSHEA in 1994 in U.S.A, so they told that the dietary supplements are the products compressed of dietary constituents and orally administered to supplement that nutritional requirement of the diet.

So, dietary supplements are defined as the products compressed of dietary constituents, so they are orally administered to supplement the nutritional requirement of the diet. So what are all those dietary constituents so they refer to bioactive components compressing of amino acids, vitamins, minerals, important metabolites and certain enzymes.

One example would be vitamin E injection what we are taking, so that is what they said us so they are the dietary constituents and orally administered to supplement the nutritional requirement of the diet. Dietary supplements also include herbs or extracts available in tablets capsules, powders, liquids and any other dosage form that I have already discussed besides fulfilling the nutritional requirement dietary supplements also participated in therapies related to various or variety of ailments.

So, not only nutrition requirement so they also take part in the therapies related to variety of elements, so if your vitamin D is reduced you may be having a bone related issues, so if you are diet is complemented with the proper level or proper dosage level of vitamin E then it side effect is you will not have any bone related issues. So that is the way it is told as it is not only fulfilling the nutritional requirement it is also participated in therapies related to variety of elements. National health organization created the standard for a balanced diet to avoid the malnutrition chances and minimize the risk related with some severe diseases, so it is the standard or created by national health organization NHO.

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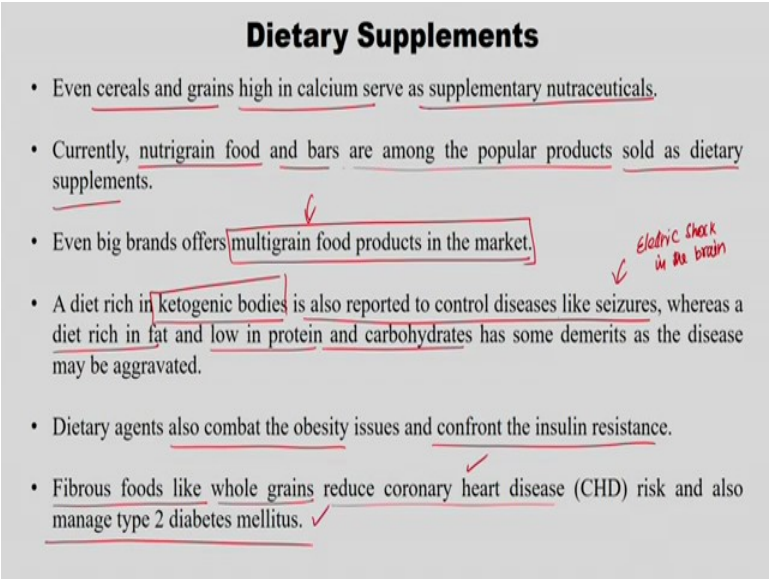

Even cereals and grinds have high in calcium serve as a supplementary nutraceuticals, currently nutrigrain food and bars are among the popular products sold as a dietary

supplements even big brands offer multigrain food products in the market instead of one particular meet only so they also combine 2 or 3 products, for example rice, wheat and your corn and ground nut, peanut so everything together so that is given as a multigrain food products. And a diet rich in ketogenic bodies is also reported to control diseases like seizures so this is nothing but kind of electric shock in the brain, so if you take ketogenic groups in the food so they can control the diseases like seizures but if the diet is rich in fat and low in protein and carbohydrates they normally aggravated the diseases.

So for example, if we give the dietary supplements as a ketogenic groups then it is reported that it controls the diseases like seizures but at the same time if the food is rich in fat and low in protein and carbohydrates so that normally aggravate the diseases like seizures it is not like even though we said vitamins, fats, protein, carbohydrates everything or functional components of the food, so certain components may be able to control diseases and certain components of the food may aggravate the particular diseases.

So, it has to be a diet or food has to be taken in proper dosage based on the diseases or based on the dosage form, so which particular component of the food should be high for which therapeutic value so that has to be determine with the scientific evidences and dietary agents also combat the obesity issues and confront the insulin resistance. So this is regarding diabetes and fibrous foods like whole grains reduce coronary heart diseases which is nothing but CHD risk and also manage type 2 diabetes mellitus, whole grains fibrous foods so they are reported to reduce the CHD coronary heart diseases and also they can manage type 2 diabetes mellitus.

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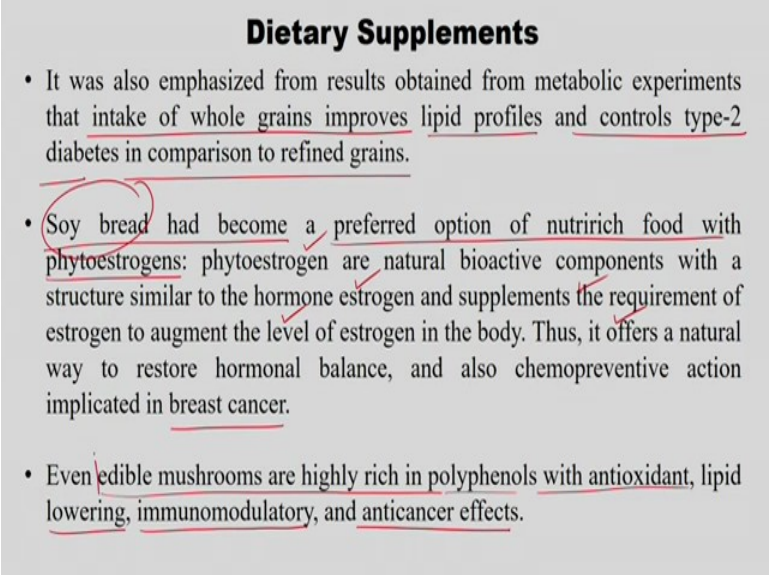

It was also emphasized from the results obtained from the metabolic experiments done the intake of whole grains improves lipid profiles and controls type 2 diabetes in comparison to refined grains. So instead of refined grains if the whole grain is taken so that can control the type 2 diabetes. And soy bread had become a preferred option of nutririch food with phytoestrogen, so already we told phytoestrogen is nothing but a similar to estragon component, so this supplements of these phytoestrogen can argument the level of estrogen and the bode thus it offers a natural way to restore hormonal balance and also chemo preventive action against the breast cancer. So this is equivalent to estrogen hormone which is present in the female. So, soy bread had become a preferred option of nutririch food with a phytoestrogen, even edible mushrooms are highly rich in polyphenols with antioxidant, lipid lowering, immunomodulatory and anticancer effects, so what are all they edible mushrooms.

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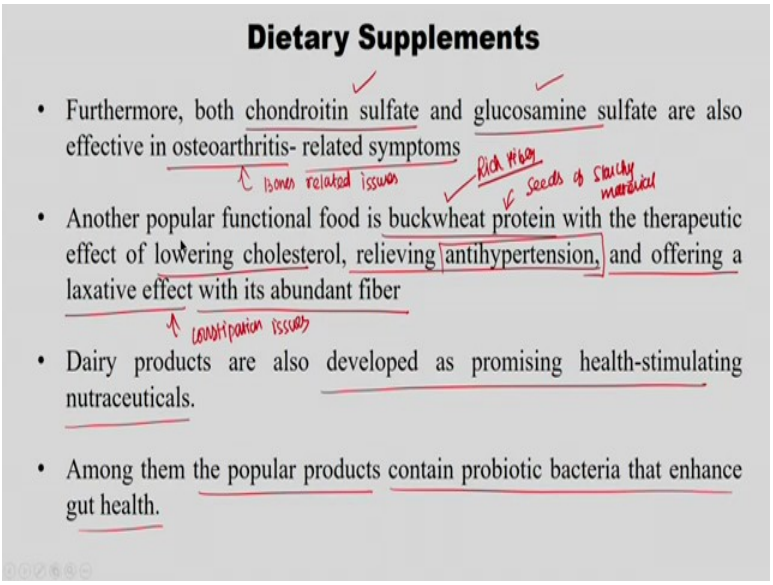

Further, both chondroitin sulfates as well as glucosamine sulfate are also effective in osteoarthritis- related symptoms, so this I have already told bone related issue bones becomes a bones become brittle, so the phytochemicals chondroitin sulfate as well as glucosamine sulfate so they act against the osteoarthritis. Another popular functional food is buckwheat protein so this is nothing but a seeds of starchy material with the therapeutic effect of lowering cholesterol reliving anti-hypertension and offering laxative effect with its abundant fiber content.

So this is against the (cosnti) constipation issues, so the buckwheat protein has a therapeutic effect of lowering cholesterol and reliving anti-hypertension and offering a laxative effect with its abundant fiber, so this is reliving tension and it is like a anti-hypertension pill, so it relieves the hyper-tension so this is nothing but a anti-hypertension agent, which is nothing but the buckwheat protein.

So, the buckwheat protein with the therapeutic effect of lowering cholesterol and reliving anti-hypertension and offering a laxative effect with its abundant fiber content, so this is rich fiber so which helps in all this therapeutic value. Dairy products are also developed as a promising health-stimulating nutraceuticals, so that we already know so milk is one of the example, among them popular products contain probiotic bacteria that enhance gut health, so this we already know so we have friendly bacterias in our guts.

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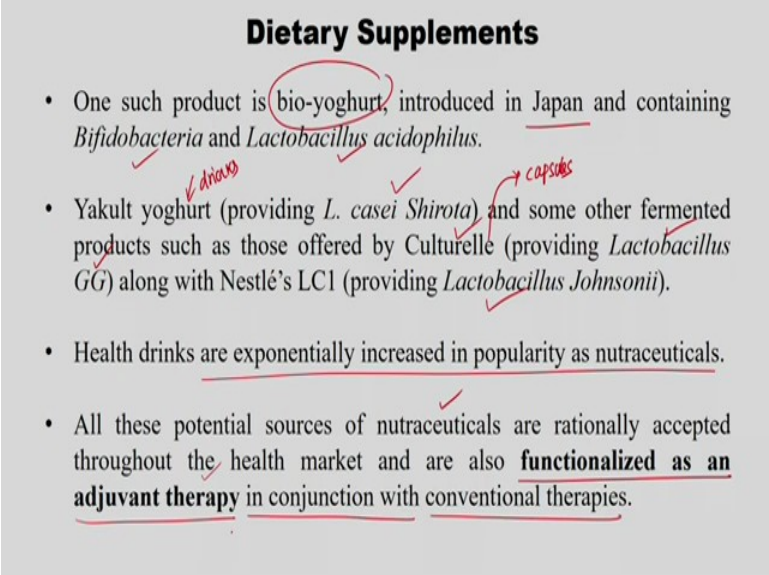

So, one such product is a bio-yoghurt, so this is introduced in Japan which contains Bifidobacteria as well as Lactobacillus acidophilus so these are probiotics and Yakult yoghurt so which provides Lactobacillus casei shirota and some other fermented products such as those offered by Culturella so which provides Lactobacillus GG and along with Nestlé's LC1 so which provides Lactobacillus Johnsonii so this is a drink, so this comes in capsules form so these are all probiotic supplements.

So, the Yakult yoghurt provides lactobacillus as casei shirota and culturella provides lactobacillus GG and Nestlé's LC1 provides lactobacillus johnsonii and bio-yoghurt you will have a Bifidobacteria as well as Lactobacillus acidophilus, health drinks are exponentially increased in popularity as nutraceuticals and all these potentials sources of nutraceuticals are rationally accepted throughout the health market and are also functionalized as an adjuvant therapy in conjunction with conventional therapies. So remember as I told earlier these nutraceuticals are accepted in the health market and they are functionalised as an adjuvant therapy but not a main therapy so they should be conjucted with the conventional therapies.

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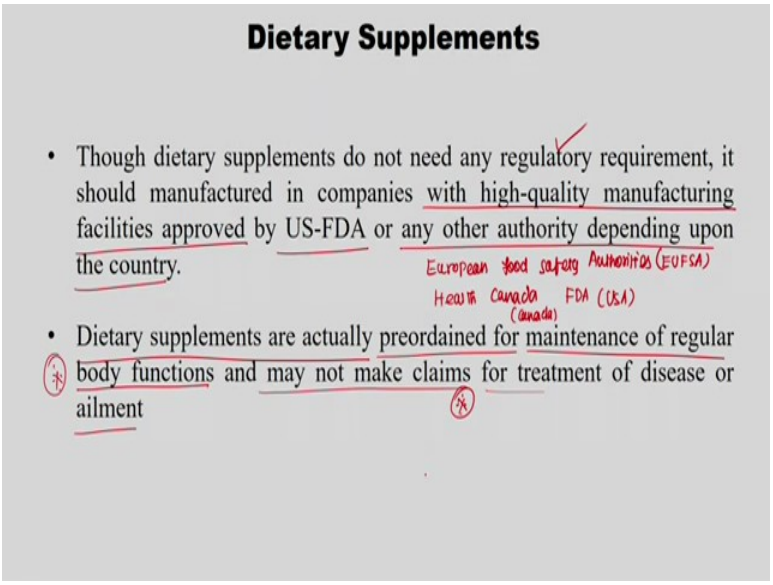

Though dietary supplements do not need any regulatory requirements it should be manufactured in companies with high-quality manufacturing facilities approved by US-FDA that food and drug administration or any other authority depending upon the country, so for example if you take Europe so it is nothing but a European Food Safety Authorities so we call it as EUFSA and Health Canada we have seen one of the definition from Health Canada and for US it is FDA so it is based on country so this is from Canada, so this is USA. So, based on the country so they should be manufactured in the companies with high-quality manufacturing facilities the dietary supplements are actually preordained for maintenance of regular body functions may not make claims for treatment of disease or elements.

So this is very much important this is what I told as a claim. So, these dietary supplements are actually preordained for maintenance of regular body functions and may not make claims for treatment of any diseases, so this is very much important point. So we cannot use them directly that as a treatment for diseases but it can be used as a adjuvant therapy in conjunction with the conventional therapies and also any such claims of that treat this particular diseases should come with the scientific evidences with properly tested in the human body.

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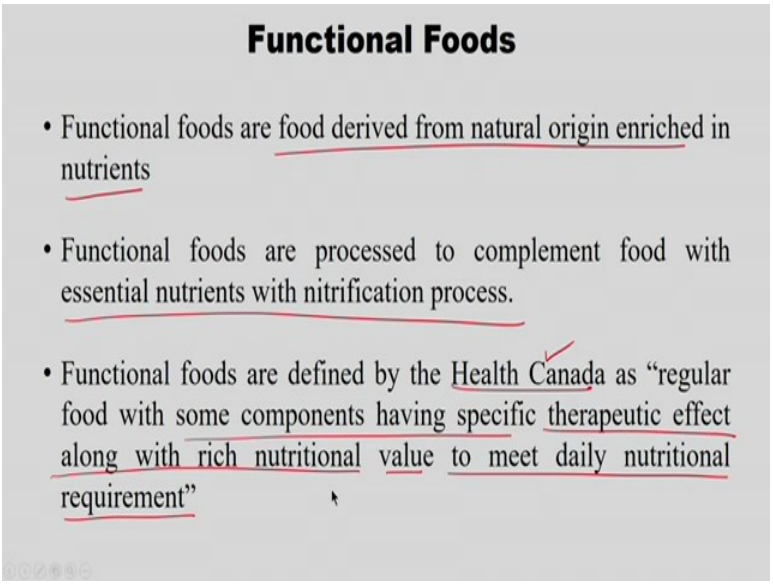

And functional foods so they are the foods derived from natural origin enriched in nutrients and functional foods are processed to complement the food with essential nutrients with the nitrification process and functional foods are defined by Health Canada as I said regular food with some components having specific therapeutic effect along with rich nutritional value to meet daily nutritional requirement. Functionalized foods are the foods with some components having specific therapeutic effect along with rich nutritional value to meet daily nutritional requirement.

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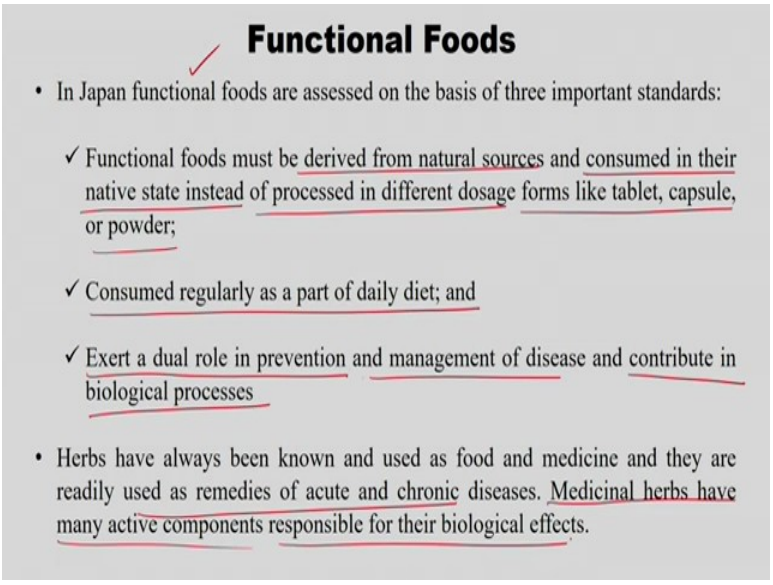

So, in from Japan functional foods so they have a 3 important standards for functional foods, 1 is they must be derived from natural sources and consumed in their native state instead of

processed in different dosage forms like tablet, capsule and powder they should be natural and instead of processed in different dosage forms such as tablets, capsules or powder and consumed regularly as a part of daily diet and exert a dual role in prevention and management of disease as well as contribute in biological processes. So these 3 standards came from Japan functional foods so in defining the functional foods. So, herbs have always been known and used as food and medicine and they are readily used as a remedies for acute and chronic diseases, and medicinal herbs have many active components responsible for their biological effects.

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Aloe vera gel (*Aloe vera* L. N.L. Burm.)	Dilates capillaries, antiinflammatory, emollient, wound healing properties
Chamomile (*Matricaria recutita* L.)	Antiinflammatory, spasmolytic, antimicrobial, wound healing
Echinacea (*Echinacea purpurea* L.)	Immunostimulant, treatment of cold and flu symptoms
Eleuthera (*Eleuthero coccussenticosus* Rupr. & Maxim., Maxim.)	Adaptogen
Ephedra (*Ephedra sinica* Stapf., *Ephedra intermedia* Schrank., *Ephedra equisetina* Bunge.)	Bronchodilator, vasoconstrictor, reduces bronchial edema, appetite suppressant
Evening primrose oil (*Oenothera biennis* L.)	Dietary supplement of linoleic acid, treatment of atopic eczema
Feverfew (*Tanacetum parthenium* L.)	Treatment of headache, fever, and menstrual problems; prophylactic to reduce frequency, severity, and duration of migraine headaches
Garlic (*Allium sativum* L.)	Antibacterial, antifungal, antithrombotic, hypotensive, fibrinolytic, antihyperlipidemic, antiinflammatory
Ginger (*Zingiber officinale* Rosc.)	Carminative, antiemetic, cholagogue, positive inotropic, treatment of dizziness

So, medicinal herbs here we are going to see this particular table I have taken from the references which is given at the end of the slide, so you can refer them. so I would like to mention one or two, one is Aloe Vera gel so which has the dilates capillaries and anti-inflammatory agents and emollient so emollient is nothing but a giving proper soothing affect and wound healing properties and if you say garlic, so they are anti-bacterial, anti-fungal and anti-thrombotic and hypotensive and febrinolytic and anti-hyperlipidemic and anti-inflammatory. The ginger will be used in therapeutic values of carminative treatment of dizziness and positive inotropic etcetera, so this particular table is available in the reference given so you may refer later.

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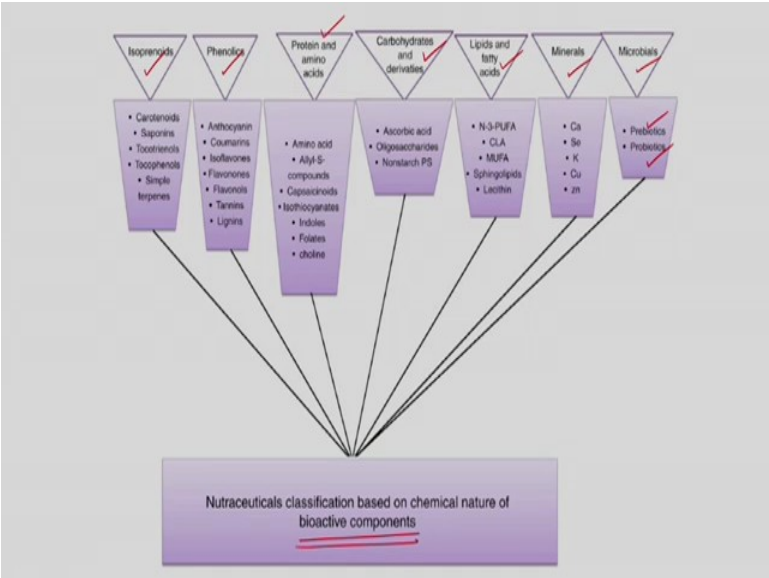

And here the bioactive components based on bioactive components we can classify the nutraceuticals as isoprenoids, phenolics, protein and amino acids, carbohydrates and its derivatives lipids and fatty acids, minerals and microbials so in the microbials you probiotic and prebiotic would come and fatty acids you know already I have discussed omega 3 and minerals, calcium, selenium, potassium, zinc and copper. And proteins are nothing but amino acids, phenolics we have already seen that flavonones, flavonols etcetera and isoprenoids are nothing but a carotenoids so that we are going to see separately.

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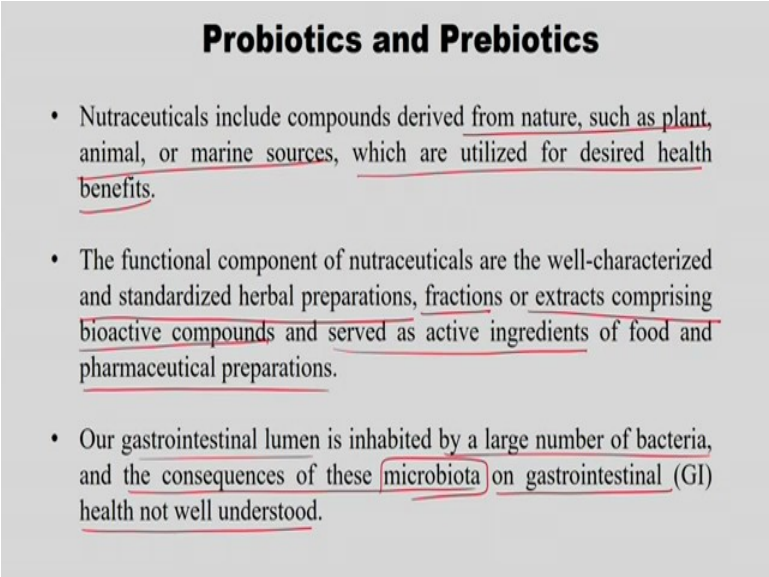

Probiotics and Prebiotics, so this is based on the bioactive components present in the nutraceuticals, so the nutraceutical already we have defined they are from nature and such as

plant, animal or marine sources which are utilized for desired health benefits and functional components of nutraceuticals are well-characterized and standardized herbal preparations, fractions or extracts comprising bioactive components and served as a active ingredients of food and pharmaceuticals preparations. Our GI lumen is inhabited by a larger number of bacteria, and the consequences of these microbiota on gastrointestinal track are not well understood, so we already know our gas intestinal lumen inhabited by a large number of bacteria which are called micro biota, so but their exact consequences still not well understood but still the research is going on.

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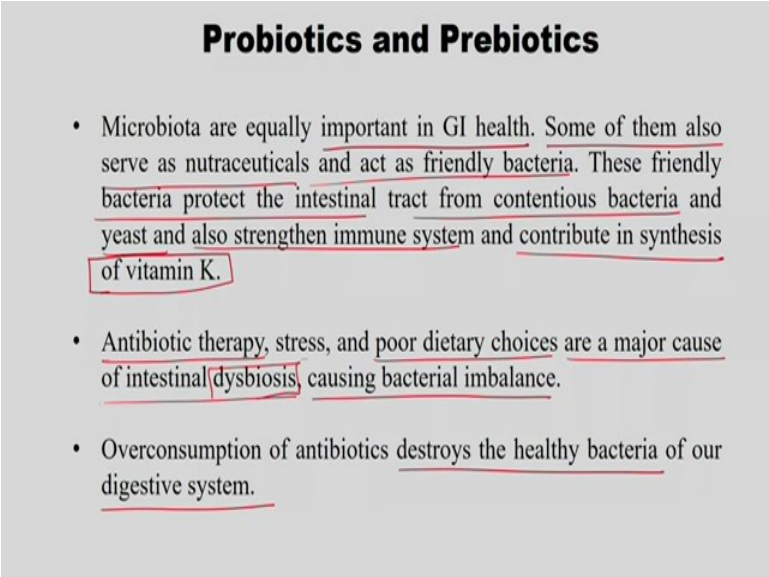

And microbiota are equally important in Gl health that is a known fact but scientific evidence are still avoided in particularly which way it helps and some of them also serve as a nutraceuticals and act as a friendly bacteria. So now the research is going on. So among those microbiota, so which particular bacteria has effect on diseases or which particular bacteria has a therapeutic value. So, these friendly bacteria protect the intestinal tract from contentious bacteria and yeast and also strengthen the immune system contribute in synthesis of vitamin K, so this particular microbiota GI contributes in the synthesis of vitamin K, also it strengthens the immune system and also it fights against the contentious bacteria.

Antibiotic therapy, stress and poor dietary choices are a major cause of intestinal dysbiosis causing bacterial imbalance. So we understood in GI tract you have a friendly bacteria as well as the contentious bacteria, so the bacterial imbalance is called as a dysbiosis. So when this particular thing happen is antibiotic therapy if we take more antibiotics or due to stress or due to poor dietary choices so there may be a bacterial imbalance, so that means the friendly

bacteria is gets killed. So, contentious bacterial population increases, so such kind of bacterial imbalance is called dysbiosis, so overconsumption of antibiotics destroys the healthy bacteria of our digestive system, so what we take as antibiotics, so it acts against all bacterias so in that way healthy bacteria also get killed.

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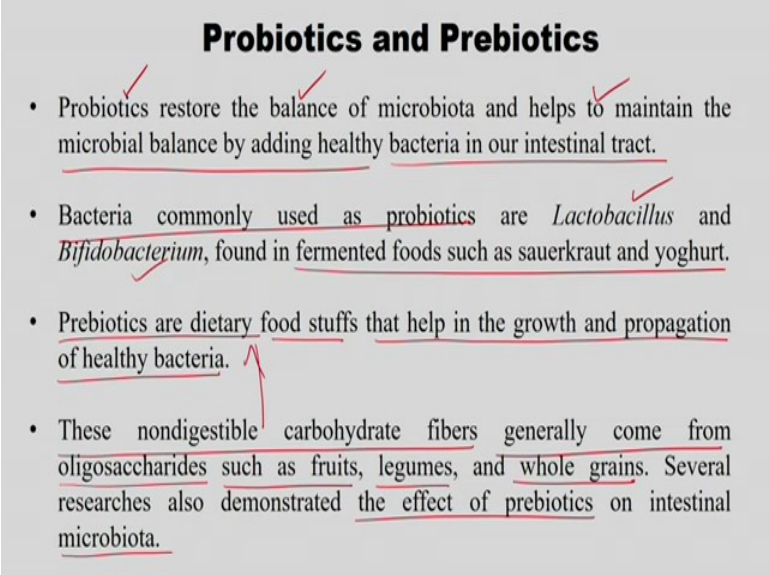

So probiotics whatever we give to restore the balance of microbiota and helps to maintain the microbial balance by adding healthy bacteria in our intestinal tract. So if such kind of dysbiosis happens, so we supposed to take probiotics supplements which restore the balance of microbiota and helps to maintain the microbial balance by adding healthy bacteria in our intestinal tract. Bacteria commonly used as probiotics are Lactobacillus acidophilus we have already seen and Bifidobacterium found in fermented foods such as sauerkraut as well as yogurt, and prebiotics are dietary food stuffs that help in the growth and propagation of healthy bacteria. So prebiotics are dietary food stuffs which help in the growth and propagation of healthy bacteria.

So, probiotics are the one in which the healthy bacteria is directly added into the intestinal tract but prebiotics are dietary food stuffs so that helps in the growth and propagation of healthy bacteria, so these nondigestible carbohydrate fibers generally come from oligosaccharides such as fruits, legumes, and whole grains. So which one these nondigestible carbohydrate fibers so these are nothing but a prebiotics dietary food stuffs so these nondigestible carbohydrate fibers generally come from oligosaccharides such as fruits, legumes, and whole grains. Several researches also demonstrated that effect of prebiotics on

intestinal microbiota. So when we take such a food stuffs which has a prebiotics affect so what its effects on GI tract so that research is also available.

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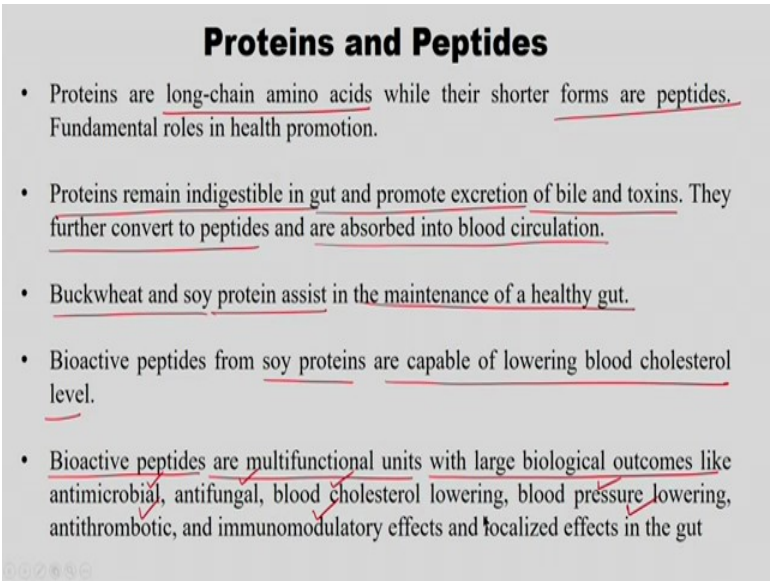

And proteins and peptides, proteins we already know they are long chain fatty acids so they also form a peptides and proteins remain indigestible in gut and promote excretion of bile and toxins and they further convert into peptides and are absorbed into blood circulation. Buckwheat and soy protein assist in the maintenance of healthy gut, and bioactive peptides from soy proteins are capable of lowering blood cholesterol level so this are all functions of proteins or applications of proteins as a nutraceuticals and bioactive peptides are multifunctional units with large biological outcomes like antimicrobial, antifungal, blood cholesterol lowering, blood pressure lowering and anti-thrombotic and immunomodulatory effects and localized effects in the gut. So proteins are involved in all these therapeutic effects.

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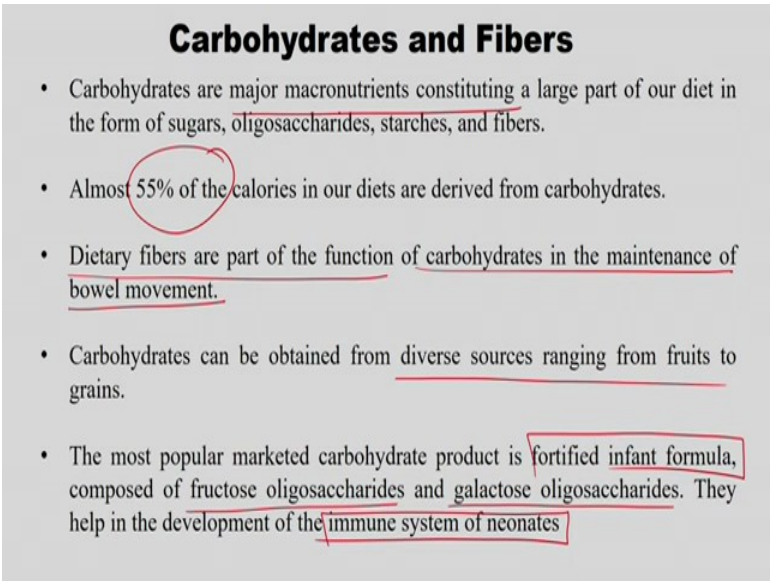

Carbohydrates are major micronutrients constituting a large part of our diet in the form of sugars, oligosacchandes, starches, and fibers. So almost 55 percentage of the calories in our daily diet are derived from carbohydrates. And dietary fibers are part of the function of carbohydrate in the maintenance of bowel movement and carbohydrates can be obtained from diverse sources ranging from fruits to grains and most popular marketed carbohydrate product is fortified infant formula, composed of fructose oligosaccharides and galactose oligosaccharides. So they help in development of the immune system of a neonates, neonates are new borns.

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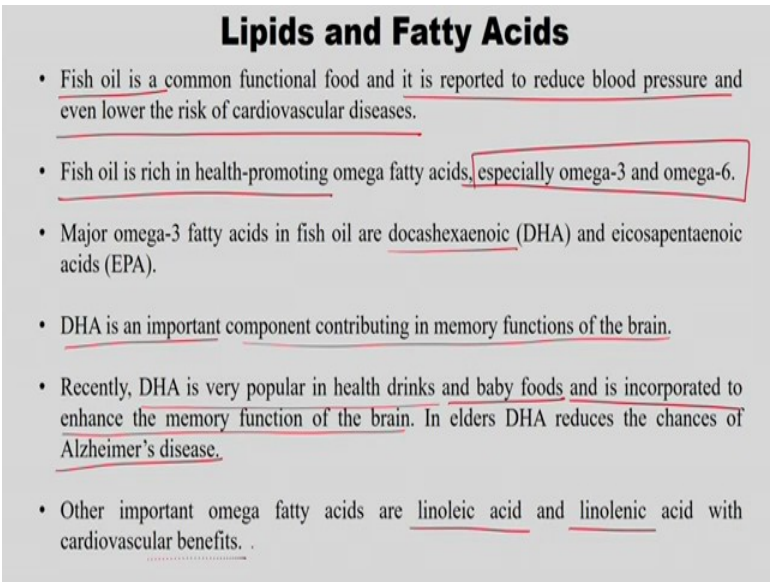

So lipids and fatty acids, so as we told already fish oil is a common functional food it is reported to reduce the blood pressure and even lower the risk of cardiovascular diseases and fish oil is rich in health promoting omega fatty acids, especially omega 3 and omega 6 fatty acids and omega 3 fatty acids in fish oil are docosahexaenoic acid and eicospentaenoic acid so DHA and EPA. DHA is an important component contributing in memory functions of the brain.

Recently DHA is very popular in health drinks and as well as baby foods you must have seen may advertisements and is incorporated to enhance the memory function of the brain, so DHA and in elders DHA reduces the chances of Alzheimer disease. In children, so DHA enhance the memory function of the brain, in elders DHA reduces the chances of Alzheimer's disease, other important omega fatty acids are linoleic acid and linolenic acid with cardiovascular benefits.

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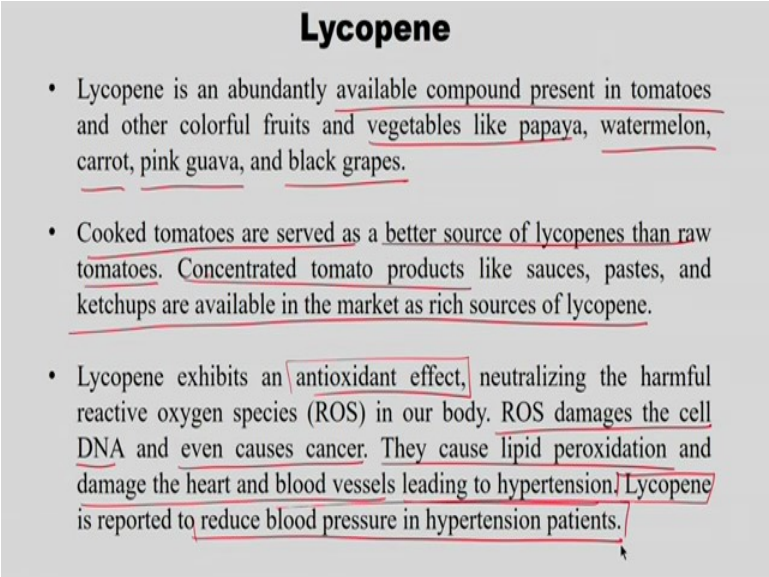

Then lycopene, so they are abundantly available compound present in tomatoes and other colorful fruits, vegetables like papaya, watermelon, carrot, pink guava, and black grapes. And cooked depth tomatoes are served as a better source of lycopenes then raw tomatoes and concentrated tomato products like sauces, pastes, and ketchups are available in the market as rich sources of lycopene.

And lycopene exhibits an antioxidant effect, neutralizing the harmful reactive oxygen species in our body. So if the oxidation happens that produces ROS which is nothing but a reactive oxygen species, so this ROS damages the cell DNA and even causes the cancer, so they cause

lipid peroxidation and damage the heart and blood vessels leading to hypertension. So, these lycopene is reported to reduce the blood pressure in hypertension patients, so that is the way it is also served as a antioxidant as well as it is reported to reduce the blood pressure in hypertension patients.

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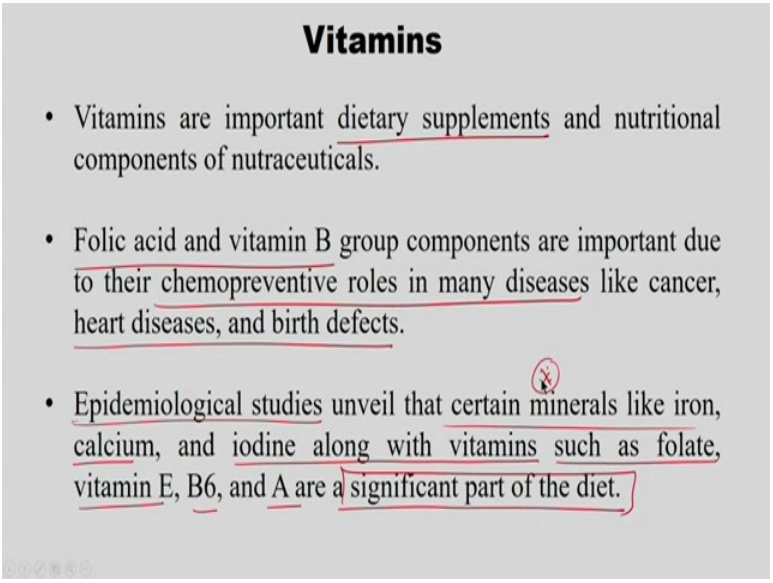

Vitamins so they are very important dietary supplements and nutritional components of nutraceuticals, so folic acid and vitamin B group components are important due to their chemopreventive roles in many diseases like cancer, heart diseases, and birth defects. And epidemiological studies unveil that certain minerals like iron, calcium and iodine along with vitamins such as folate, vitamin E, B6 and A are a significant part of the diet. So these are all to be in the diet as a, significant food components.

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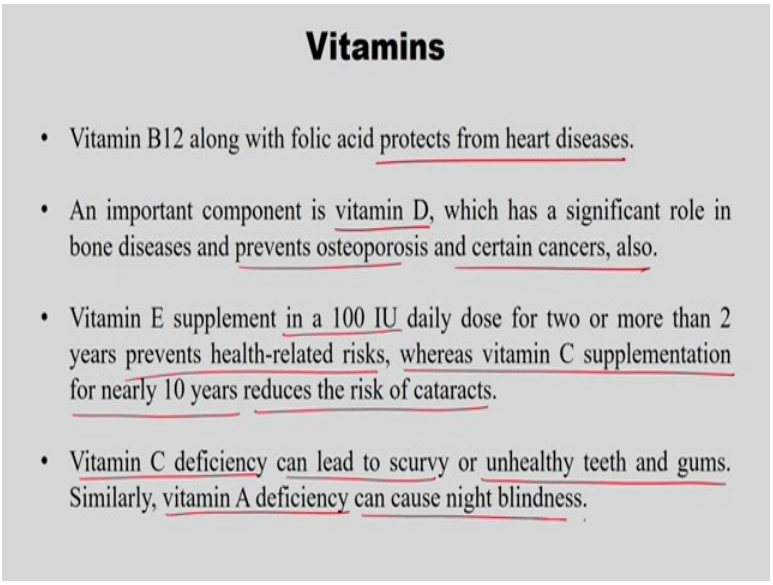

Vitamin B12 along with folic acid protects from heart diseases, like vitamin B12 is important for heart diseases, and another important component is vitamin D which has a significant role in bone diseases and it also prevents osteoporosis and certain cancers, so this I have told during the dietary supplements as well. And a vitamin E supplement in a 100 international unit daily dosage for 2 hour more than 2 years prevents the health related risk, whereas vitamin C supplementation for about nearly 10 years reduces the risk of cataracts. And vitamin C deficiency can lead to scurvy or unhealthy teeth and gums. Similarly, vitamin A deficiency can cause the night blindness.

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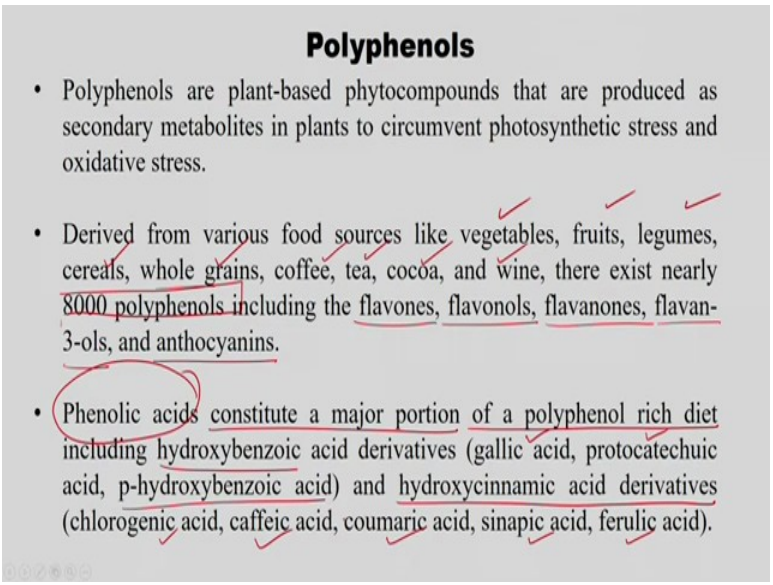

So the next and last one is polyphenols, so the polyphenols are plant based phytocompounds they are produced as a secondary metabolites in plants to circumvent photosynthetic stress and oxidative stress, to circumvent the photosynthetic and oxidative stress they produce the phytochemicals and derived from various food sources like vegetables, fruits, legumes, cereals, whole grains, coffee, tea, cocoa, wine, there exist nearly 8000 polyphenols including flavones, flavonols and flavanones and flavan-3-ols and anthocyanins.

So most of them we have also seen in the phytochemicals in few slide earlier. The phenolic acids constitute a major portion of a polyphenols rich diet including hydroxybenzoic acid derivatives which are garlic acid, photocatechuic acid and p-hydroxybenzoic acid and hydroxycinnamic acid derivatives which are nothing but chlorogenic, caffeic and coumaric and sinapic and ferulic acid. So not only phenols, polyphenols the phenolic acid are also the major portion of polyphenols rich diet in which includes hydroxybenzoic acid derivative as well as hydroxycinnamic acid derivatives, so the examples are given here.

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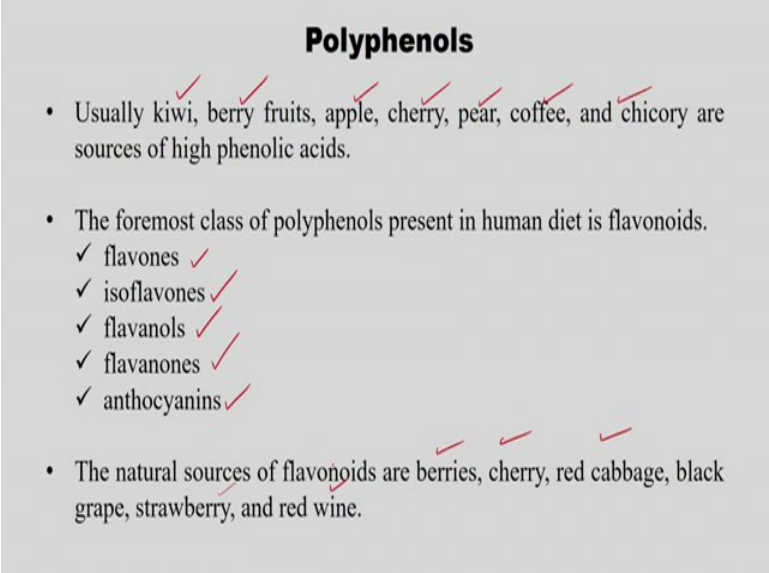

So, usually what are all the food varieties where polyphenols are present kiwi, berry fruits, apple, cherry, pear, coffee, chicory are source of high phenolic acid. The class of polyphenols present in human diet is a, flavonoids, so flavonoids which also contains major components which are flavones, isoflavones and flavanols and flavanones and anthocyanins. So everything also comes under the category of flavonoids. The natural sources of flavonoids are berries, cherry, red cabbage, black grape and strawberry and wine, so which also contains these components.

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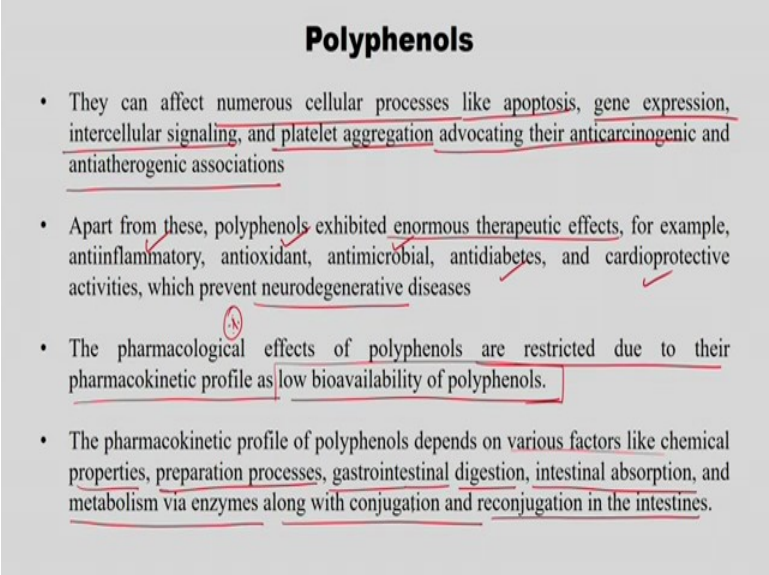

So they can affect numerous cellular processes like apoptosis, gene expression, intercellular signaling and platelet aggregation advocating their anticarcinogenic and antiatherogenic association, apart from this, polyphenols exhibited enormous therapeutic effects, for example anti-inflammatory, anti-oxidant, anti-microbial, anti-diabetes, cardio protective activities which prevent neurodegenerative diseases. The pharmacological effects of polyphenols are restricted due to their pharmacokinetic profile as a low bioavailability of polyphenols, so this is important because when it goes to GI tract it cannot be observed by the GI tract, so that is main disadvantage, so the pharmacokinetic profile as low availability of polyphenols.

So, that means the pharmacological effects of polyphenols are restricted due to their pharmacokinetic profile as low bioavailability of polyphenols, so the pharmacokinetic profile of polyphenols depends on various factors like chemical properties preparations of process and gastrointestinal digestion and intestinal absorption and metabolism via enzymes along with conjugation and reconjugation in the intestines. So, normally these polyphenols may not be fully absorbed in the intestinal tract due to that low bioavailability, so these pharmacological effects of polyphenols are restricted based on their pharmacokinetic profile, so without its pharmacokinetic profile so we cannot comment on anything on their pharmacological effects even if you take as a oral administration so it cannot be observed in the GI tract.

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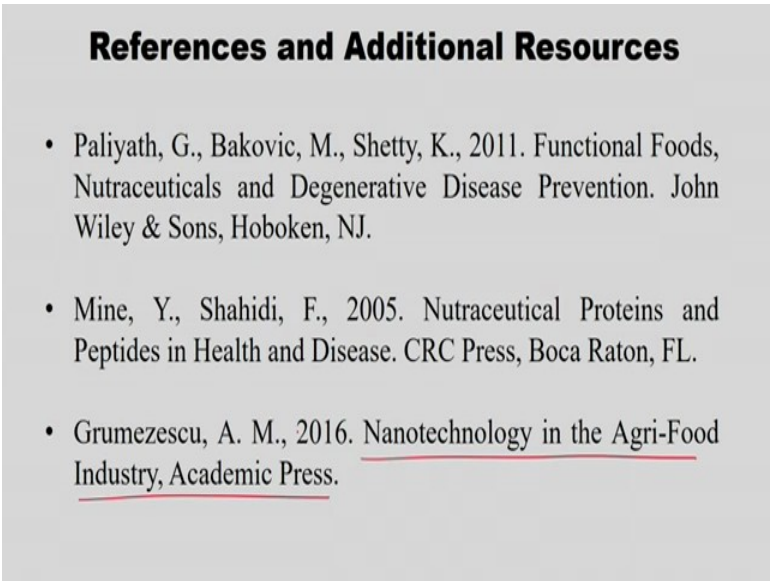

So that is all about the nutraceuticals and these are your references and additional resources you may like to refers for further. So the today's lecture mostly taken from this particular references and you can refer other to also to get to know, and as I said in the starting of the lecture so the therapeutic values or their therapeutic nature of all these bioactive components taken from the book which has also got proper scientific evidences. So, without which it cannot be taken directly, so that one should remember. So with this I will end this lecture and we will see tomorrow about the food packaging materials, thank you.