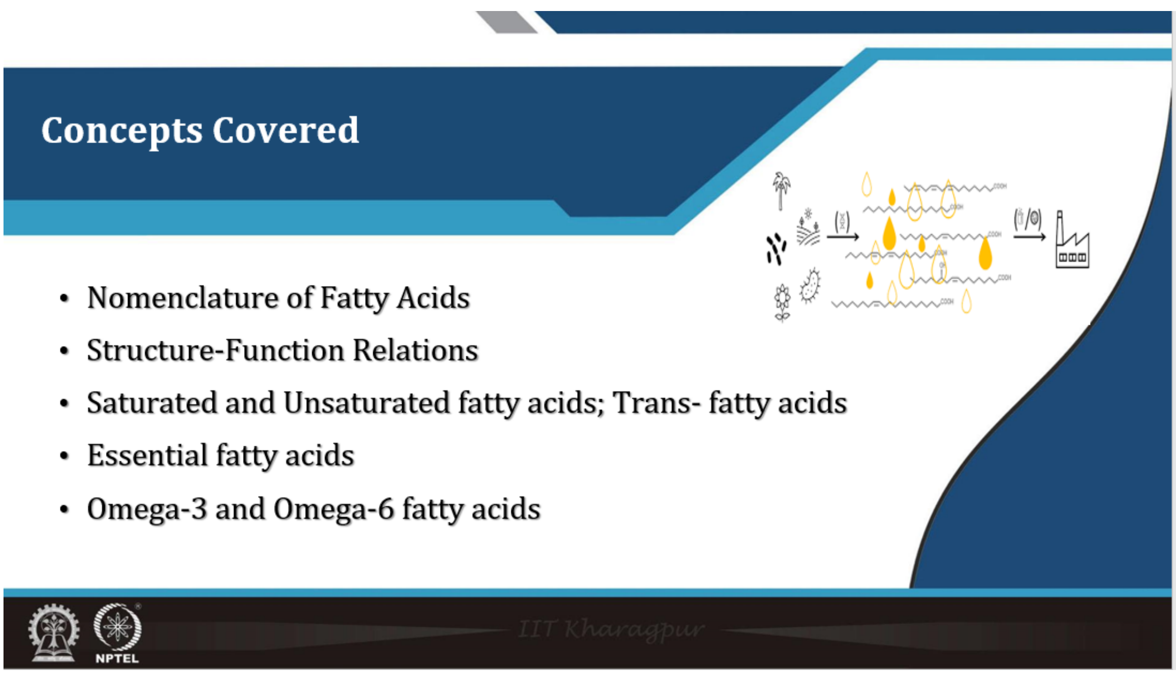
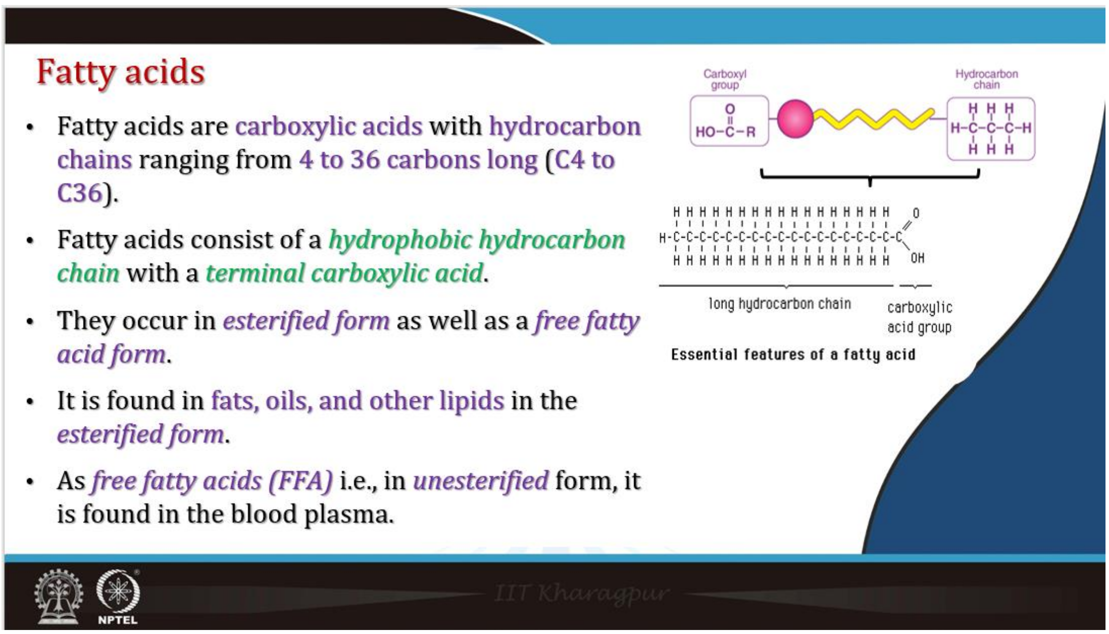
Food Oils and Fats: Chemistry & Technology
Professor H N Mishra
Agricultural and Food Engineering Department
Indian Institute of Technology Kharagpur
Week 1: Course Overview and Introduction
Lecture 7: Fatty Acids and Their Types

Hello, everybody. Namaskar. Now, we are in the 7th lecture of this course. Today, we will discuss about fatty acids and their type.



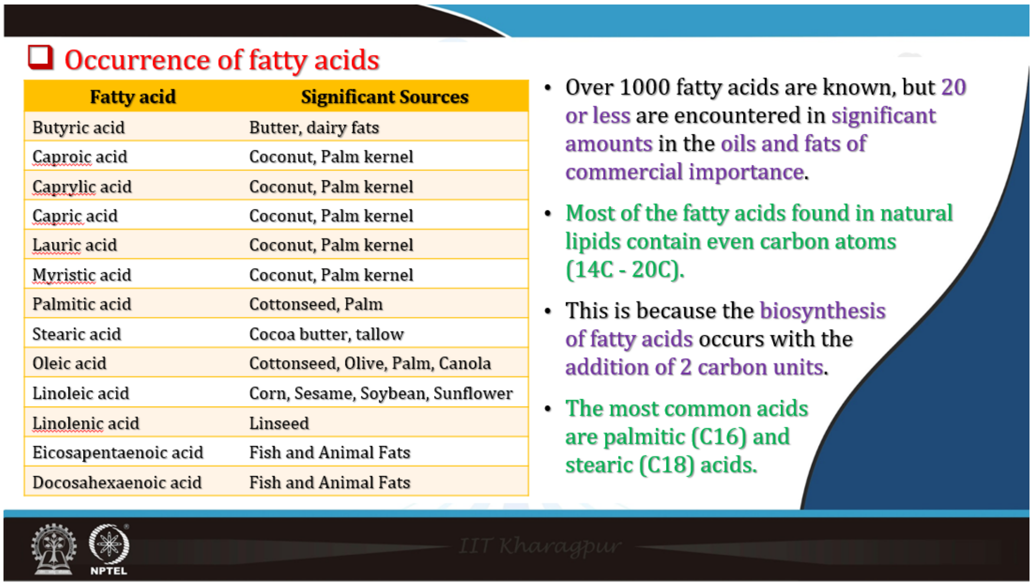
The topics which we covered or concept that we will cover in today lecture include that what are the different nomenclatures, how we name fatty acids. In the earlier class, I gave you a brief idea about what are the fatty acids. So, in the today's class, we will discuss about their naming, their structure function relationships, what are different types of fatty acids like saturated fatty acids, unsaturated fatty acids, trans fatty acids, essential fatty acids, omega 3, omega 6 fatty acids and so on, ok.



So, you know the earlier also I had given you a brief description about fatty acids. Let me revise it and say a phrase that fatty acids are carboxylic acids with hydrocarbon chain ranging from 4 to 36 carbons, ok. You can see in the figure here that these fatty acids, they consist of a hydrophobic hydrocarbon chain that is the CHCHCH and one end will be the CH3 end that is called methyl end and then on the other end, it has a carboxylic group.

So, that is the terminal carboxylic group and this is called as a carboxylic end. So, the fatty acids there are two, one is the hydrophobic hydrocarbon chain and then in one end, it is methyl group of the hydrocarbon and the other end is having a carboxylic COOH group. So, that is called a fatty acid, ok. They occur in esterified form as well as in the free form. Generally, free form those fatty acids are there commonly known as free fatty acids.

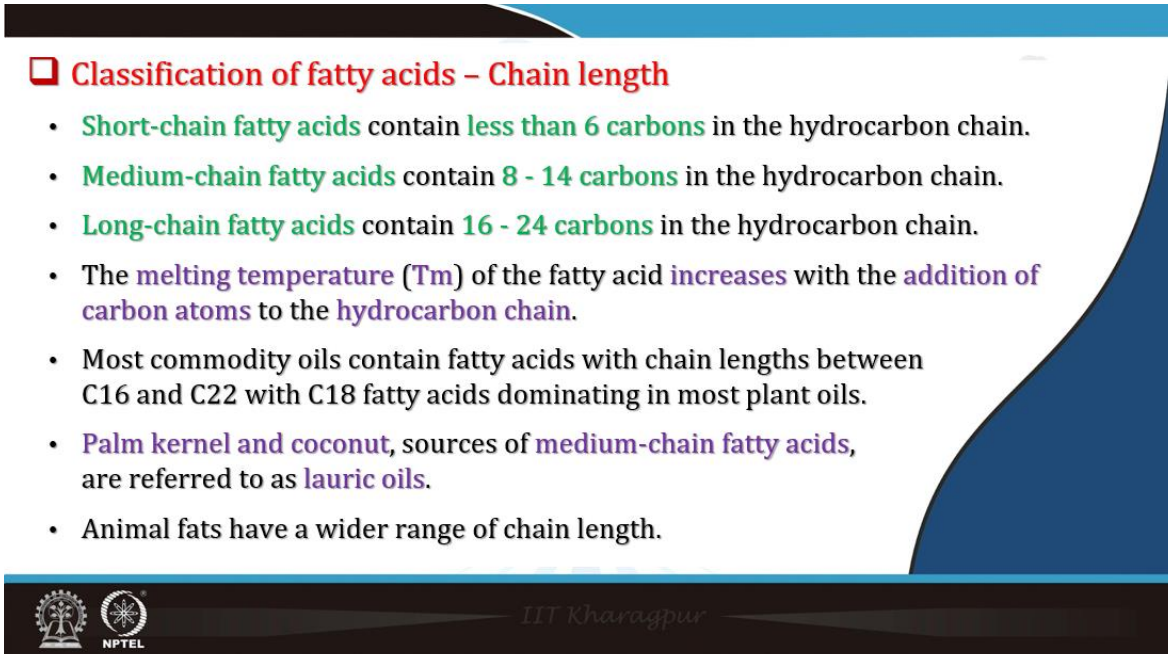
It is found in fats, oils and other lipids in the esterified form. As free fatty acids in unesterified form, it is found in the blood plasma, ok.



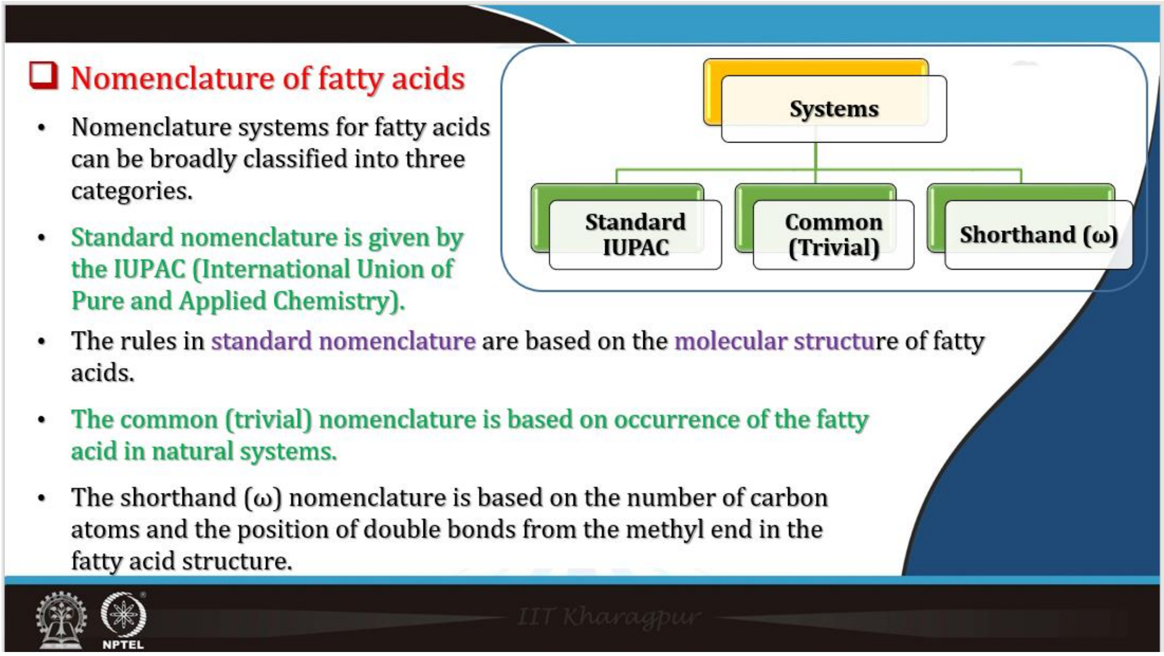
So, there are over 1000 fatty acids known, but only about 20 or so or even less than that are encountered in significant amounts in the oils and fats of commercial importance. You can see the most of the fatty acids which are found in natural lipids, they contain even number carbon atoms and mostly ranging between 14 to 20 carbon atoms and this is because of the mainly the biosynthesis pattern of the fatty acids which occurs within the addition of two carbon units. The most common acids which are found in the food fats and oils are generally 16 carbon containing palmitic acid and 18 carbon containing stearic acid.

Here in the table, I have given you a list of the commonly found fatty acids in normal food, plant and animal origin like glutaric acid is generally a prominent fatty acids found in the dairy fats. Then caproic acid, caprylic acid, capric acid, lauric acid and even myristic acid, they are all found in significant amount in coconut as well as in palm kernel and these are all saturated fatty acids, ok. The other like palmitic, stearic, oleic, they are found in cotton seed, palm, cocoa butter, tallow, even olive, canola and so on. Linoleic acid is found in good amount in corn, sesame, soybean and sunflower.

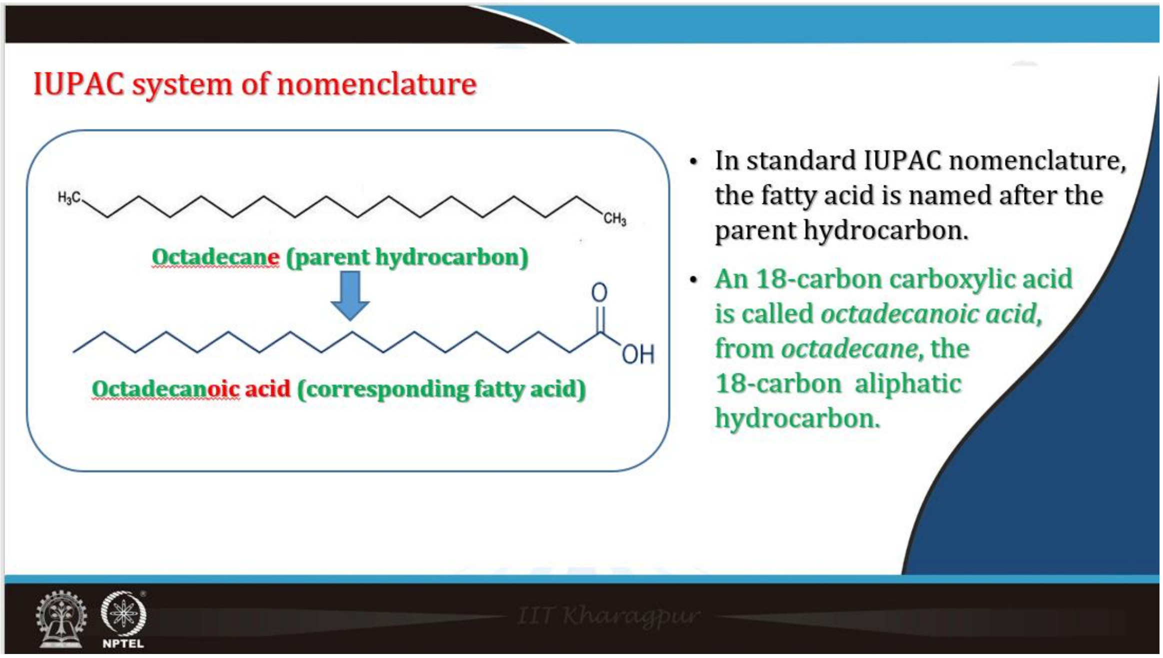
Linolenic acid is found in the linseed, ok. Similarly, ecosapentanoic acid or docosa hexanoic acid, they are found in the fish as well as in animal fats.



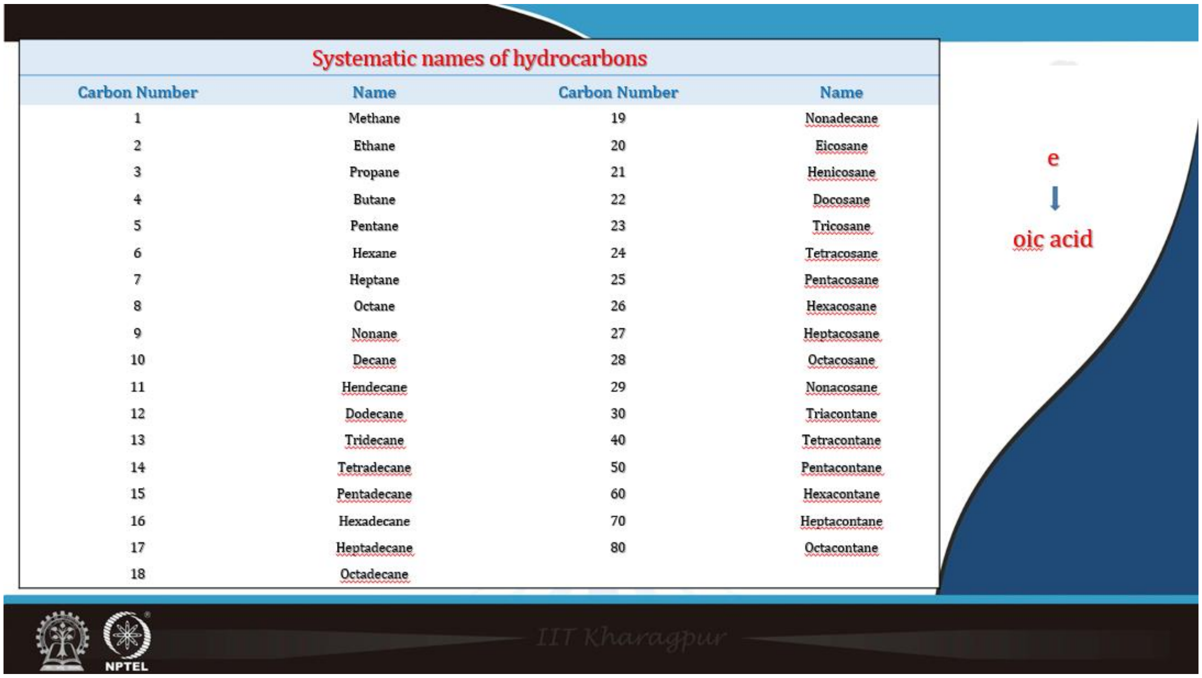
If you see that mostly the fatty acids, if you want to discuss about their classification, there are different ways of classifying them and one common classification is on the basis of their chain length that is mainly on the number of carbon atom which are present in the fatty acids. So, they are known as short chain fatty acids which contain less than 6 carbon atom in the hydrocarbon chain, medium chain fatty acids that contain between 8 to 14 carbon atoms in the hydrocarbon chain and the long chain fatty acids that contain 16 to 24 carbon atoms in the hydrocarbon chain. The melting temperature of the fatty acids increases with the addition of carbon atoms in the hydrocarbon chain means longer the fatty acid chain in the triglyceride, the higher will be the melting point or melting temperature for that fat. Most commodity oils contains free fatty acids or fatty acids with chain length between C 16 and C 22 with C 18 fatty acid dominating in most of the plant oils. Palm kernel and coconut sources of they contain medium chain fatty acids and they are referred to as lauric oils. So, these animal fats have a wider range of chain length.



So, let us discuss about nomenclature of the fatty acids that is the there are generally three systems which are used for nomenclature that is one is the standard IUPAC system, then common system in which this certain all these fatty acids that they are given some trivial names and then short hand or there is some short system short names is given to the fatty acids ok. So, standard nomenclature obviously is given by IUPAC it is International Union of Pure and Applied Chemistry. And the rules in the standard nomenclatures are based on the molecular structure of fatty acids. Common trivial nomenclature is based on the occurrence of the fatty acid in natural systems and the short hand that is omega nomenclature is based on the number of carbon atoms and the position of double bond from the methyl end of the fatty acid structure ok.



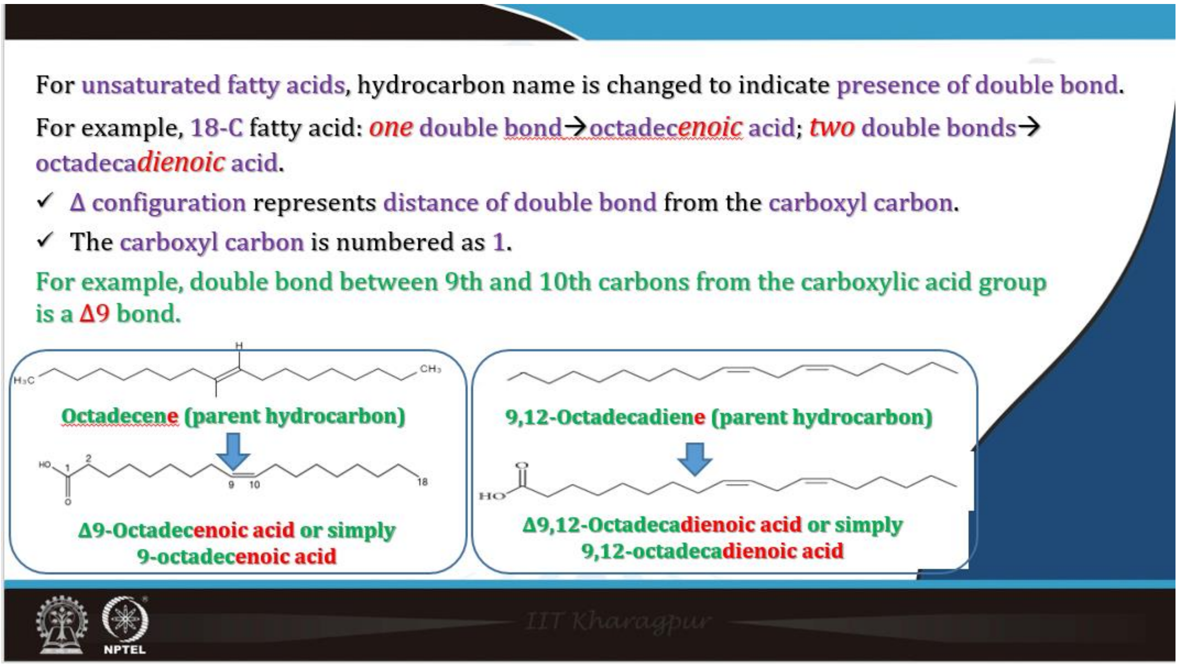
So, IUPAC system you can see in this the fatty acid is named after the parent hydrocarbon ok. And for example, an 18 carbon carboxylic acid is called octadecanoic acid ok and its parent hydrocarbon is octadecane that is the 18 carbon aliphatic hydrocarbon you can see in the structure here that is CH3 that is CH3. So, it is a 18 carbon containing hydrocarbon chain. So, it is octadecane. So, when this is converted into a carboxylic acid fatty acid that is one end is OCH3 other end becomes COOH then it becomes the corresponding fatty acids. And in the name normally that is the large letter last letter E is converted into OIE or E is replaced with OIC ok. So, octadecane becomes octadecanoic acid that is the fatty acids ok.



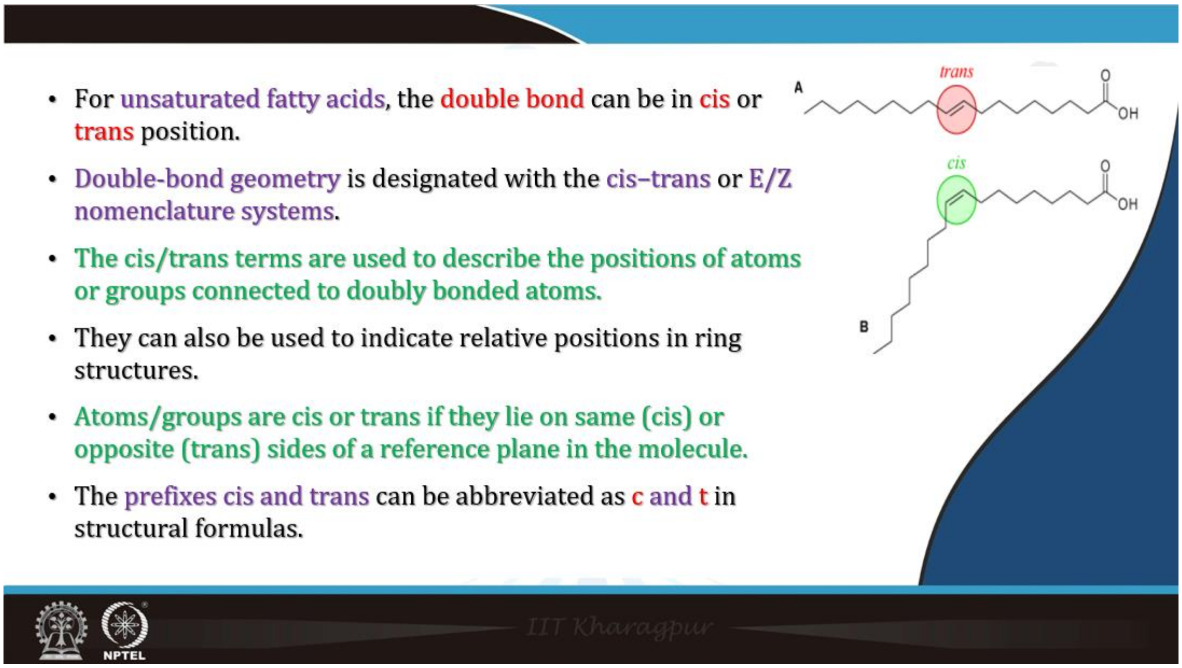
Systematic names of hydrocarbons

Carbon Number	Name	Carbon Number	Name
1	Methane	19	Nonadecane
2	Ethane	20	Eicosane
3	Propane	21	Henicosane
4	Butane	22	Docosane
5	Pentane	23	Tricosane
6	Hexane	24	Tetracosane
7	Heptane	25	Pentacosane
8	Octane	26	Hexacosane
9	Nonane	27	Heptacosane
10	Decane	28	Octacosane
11	Hendecane	29	Nonacosane
12	Dodecane	30	Triacontane
13	Tridecane	40	Tetracontane
14	Tetradecane	50	Pentacontane
15	Pentadecane	60	Hexacontane
16	Hexadecane	70	Heptacontane
17	Heptadecane	80	Octacontane
18	Octadecane		

So, here in this slide I have given you some standard common names of the IUPAC system that is the number of carbons in the hydrocarbon and its name like the one carbon obviously CH4 is the methane because carbon has one valency and it has a four linked with the single bond four hydrogen atoms. So, it becomes so CH4 it is hydrocarbon it is containing one carbon is methane alright. Similarly, ethane, propane, butane, pentane that is with the depending upon the number of carbon atom present in them. You can see here that is 16 carbon containing fatty acid is hexadecan, 18 carbon containing fatty is octadecan. So, 18 carbon in the last slide I have show you it becomes octadecanoic acid. Similarly, 16 carbon containing that is hydrocarbon when it will be converted into fatty acids then it will be hexadecanoic acids ok. 22 carbon containing fatty acid is docosane. So, its fatty acid will be docosanoic acid. So, means E that is the last letter you see in almost all the names. So, E is replaced with OIC is two words.

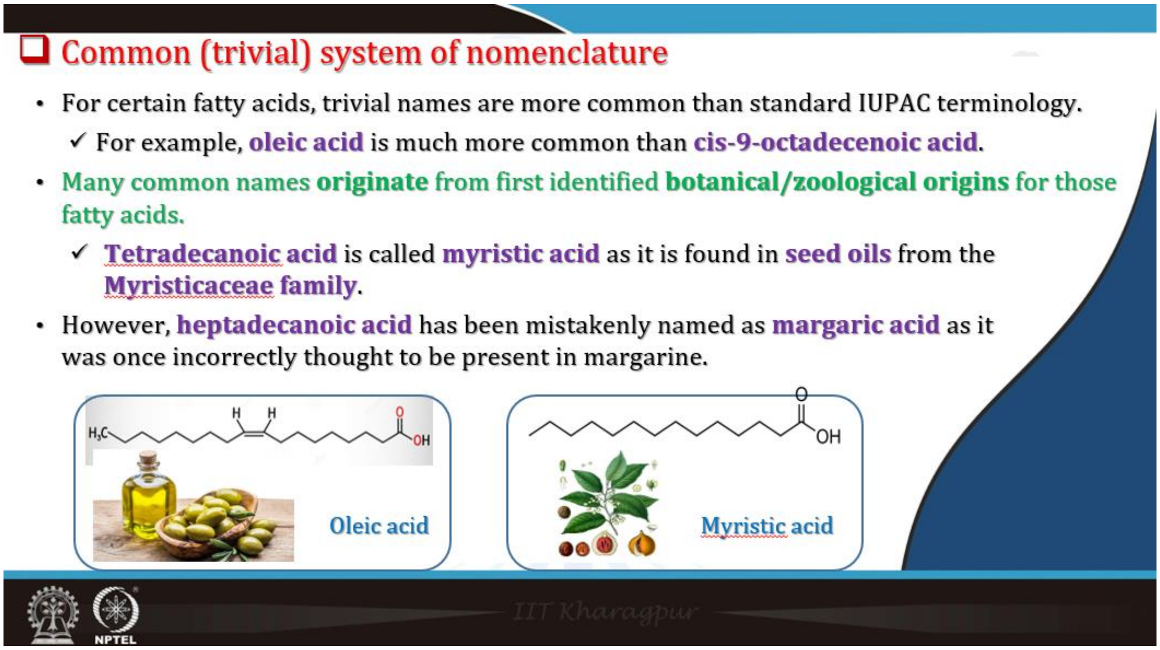


For unsaturated fatty acids hydrocarbon name is changed to indicate the presence of double bond. For example, 18 carbon containing fatty acids if it has one double bond then it will become octadecenoic acid. Octadecenoic acid means one double bond, but if there are two double bonds in this then it will become name will become octadecadienoic acid. Mono enoic acid one bond and di enoic acid is two double bond. So, that is this triangle configuration it represents the distance of the double bond from the carboxyl atom that is it shows that unsaturated linkage that is the symbol normally double bond unsaturation and it shows that the position where this double bond exist like here you see that this symbol and then 9,12 - octadecadienoic acid or simply one can write 9,12-octadecadienoic acid means that is the symbol is that the double bond starts first at the ninth carbon atom and then second double bond is at the 12th carbon atom. So this is and the carboxyl carbon atom always is a numbered as number one that is the numbering of the hydrocarbon chain it starts from the carboxylic end carboxylic carbon atom COOH C of the COOH is counted as number one and then 2 3 4 5 it will go on and so on.



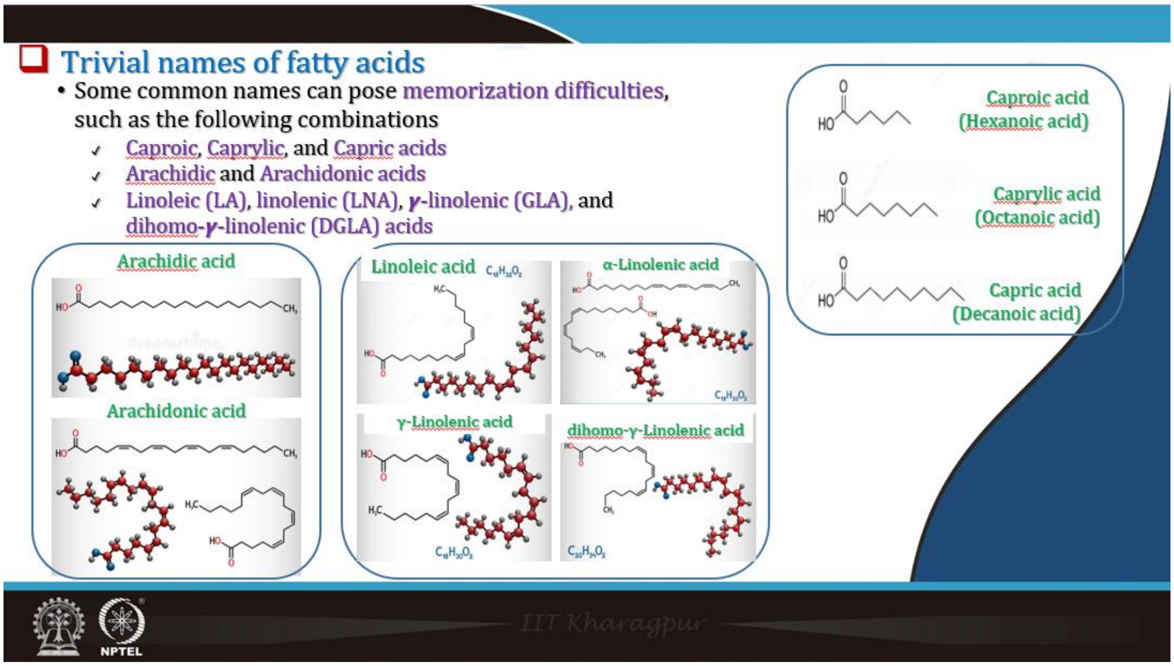
So for the unsaturated fatty acids the double bond can be either in cis position or in trans position. So, therefore, double bond geometry is designated with the cis-trans nomenclature system. So, the cis-trans terms are used to describe the position of atoms or groups connected to double bonded atoms. They can also be used to indicate the relative positions of the in the ring structures that is atoms and groups they are cis or trans if they lie on the same side or on the opposite sides of the reference plane in the molecule. The prefixes cis and trans can be abbreviated in the structure writing system like c or t in the structural formulas. So, you can see here to elaborate little more that is a cis one there are two hydrocarbons where one trans is indicated and C is indicated, cis is indicated means that is in the carbon hydrocarbon chain as you see that is each carbon is having that is a CH2, CH2, CH2 linkages are there means that it has that the hydrogen links in between them.

So, if these two hydrogen which are connected with the two carbon atoms if they are on the same side of the chain poly hydrocarbon chain or the plane then it becomes cis and if they are on the opposite side like here it is on the other side this opposite side then it becomes the that is the hydrogen which are connecting the two carbon atoms which are connected with a double bond. If the hydrogen atoms are on both the carbon atoms are on the same side the resulting fatty acids will become cis, if they are on the opposite side the resulting fatty acid will become trans.



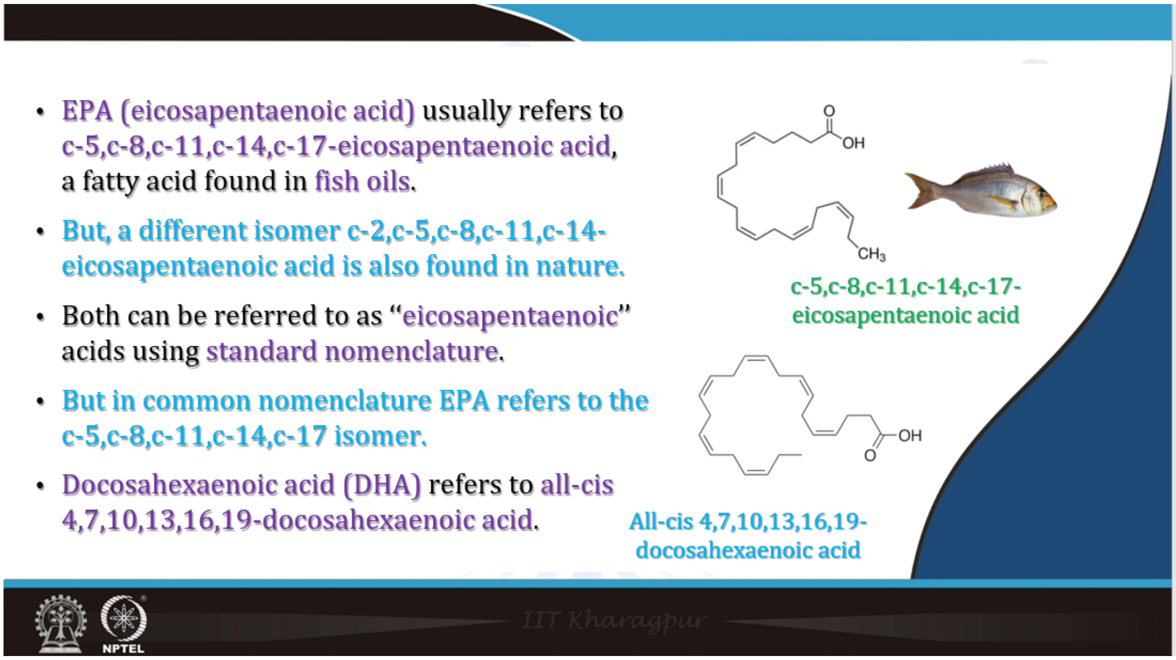
The trivial or common system of nomenclature of fatty acids. In this the common that is it is a normally and let me say that this is the common system of is more is used because the names are little simple here alright and normally that is a they are the most of the common names of the fatty acids originate from the first identified botanical or geological origin for those fatty acids. For example, tetradecanoic acid is called myristic acid as it was found in the it is found in the seed oils from the Myristicaceae family.

Generally however, heptadaconoic acid has been mistakenly named as margaric acid as it was once incorrectly thought to be present in margarine, but so in many cases that is the like linolenic acid it is found in the linolenic that is linseed that is it becomes oleic acid from the olive. So generally these names they originate from the source that is from where it is this ok.

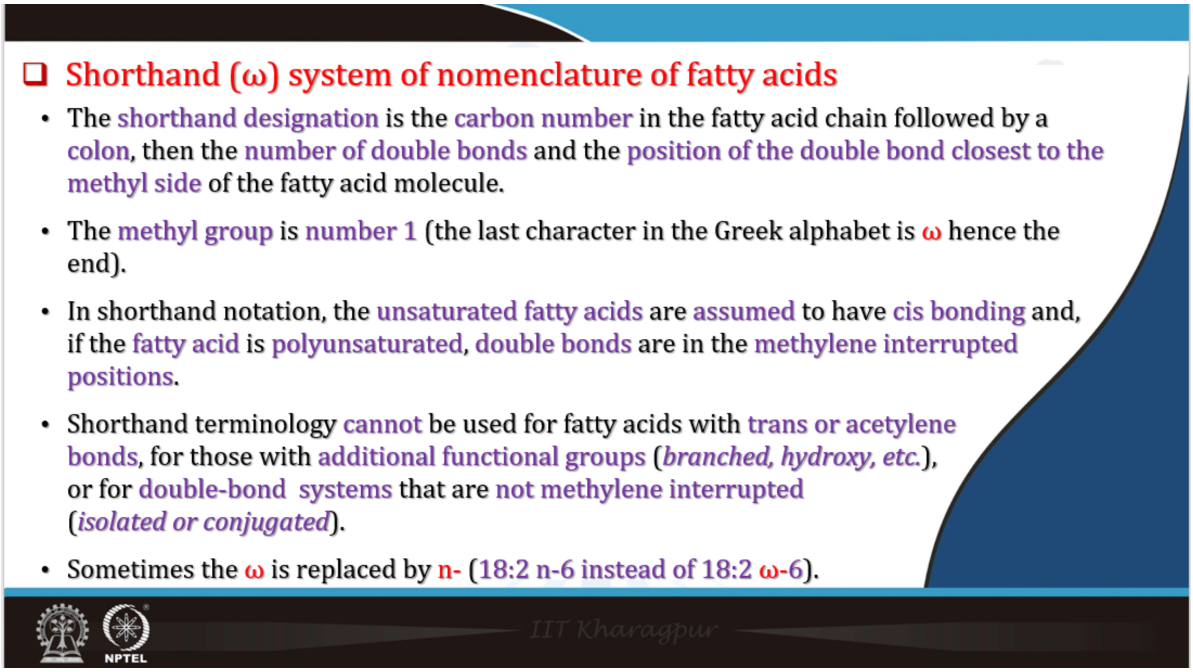


The common name like and they because sometimes although this IUPAC name is very systematic one can easily understand, but sometime it becomes difficult to remember. So in daily usage these common names are more used than the systematic name. So the some of the common names can pose however, memorization difficulties such as the combination like caproic acid, caproic, caprylic, capric although all these remain almost similar in nature ok, but there are certain differences.

Similarly arachidic and arachidonic, linolenic, linolenic, gamma linolenic, dihomo gamma linolenic acid and so on. So, here in the structure I have just shown you some of the trivial names of the saturated unsaturated fatty acids as well as saturated fatty acid like for example, hexanoic acid which is caproic acid, octanoic acid which is caprylic acid, decanoic acid which is capric acid and so on. Similarly arachidonic. Arachidic acid is the saturated fatty acid when it desaturates becomes arachidonic acid. Linoleic acid, alpha linolenic acid, gamma linolenic acid, dihomo gamma linolenic acid all these names are mainly there are differences in the position and number of the double bond or and saturation in the fatty acid.



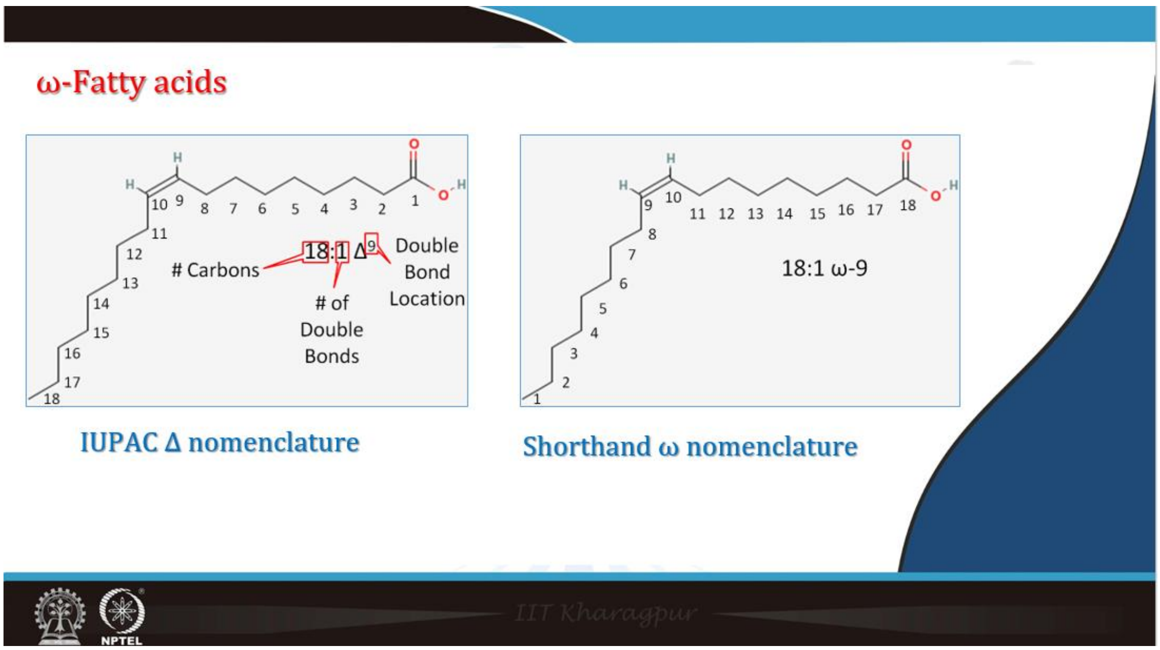
EPA that is Eicosapentaenoic acid usually referred to as cis 5, cis 8, cis 11, cis 14, cis 17 Eicosapentaenoic acid which is a fatty acid that is commonly found in fishes that is the structure you can see here these are the cis structure that carbon positioning is given and all these are cis because the hydrogen on these carbon atoms are on the same side. But a different isomer like 2 cis, 5 cis, 8 cis, 11 cis, 14 cis Eicosapentaenoic is also found in nature that is it can be there is a common nomenclature in EPA refer to the C 5, C 8, C 11, C 14, C 17 isomer. Docosahexaenoic acid there is commonly known as DHA refers to all cis that is all cis means at 4, 7, 10, 13, 16, 19 there is a there is carbon atoms they contain cis hydrogen at the cis position. So, these are all 6 all cis 4, 7, 10, 13, 16, 19 docosa hexanoic acid that is DHA.



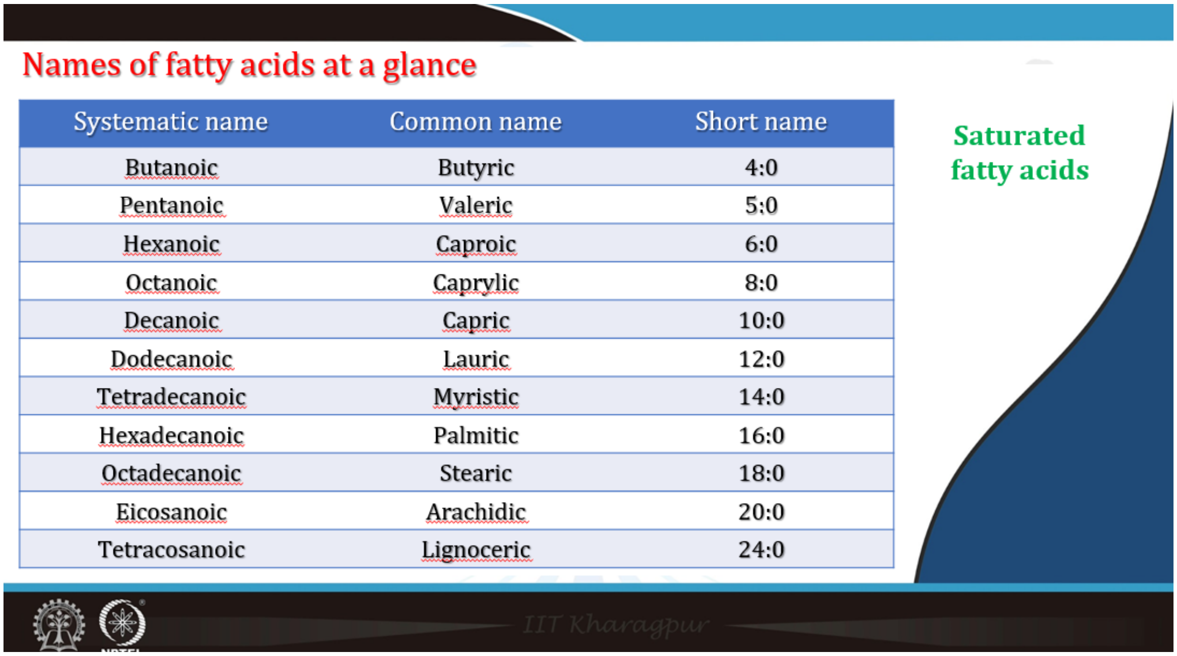
So, the short hand or omega system of nomenclature of the fatty acids this in this system the nomenclature of the fatty acid the carbon number in the fatty acid chain length is followed by a column and then the number of the double bond and the position of the double bond closest to the methyl side of the fatty acid molecule is shown.

That is fatty acid as I told you earlier it has a carboxylic and it has methyl end. So, methyl end normally is also called as omega end. So, in the omega a dash and then a number that is number at which the first double bond starts. So, that is the omega system and also there will be total number of carbon atoms present in the chain. That is the methyl group is number 1 and in the short hand notation the unsaturated fatty acids are assumed to have cis bonding and if the fatty acid is polyunsaturated the double bonds are in the methyl interrupted positions.

Shorthand terminology cannot be used for fatty acids with trans or methyl end bonds for those with additional functional groups like branch, hydroxy etcetera they are in the double bond system that is are not methylin interrupted isolated or conjugated. That is sometime omega is replaced by n in the fatty acid short hand nomenclature. For example, you see here that is 18 2 n 6 it shows or it is the same 18 2 omega 6. 18 colon 2 means that is it has a that is total 18 numbers of carbon are there in the hydrocarbon chain in the fatty acid hydrocarbon chain. It has two double bond and the position starts at that 6 that is the from first from the omega end that is fatty methyl group end at the 6th position is the n.

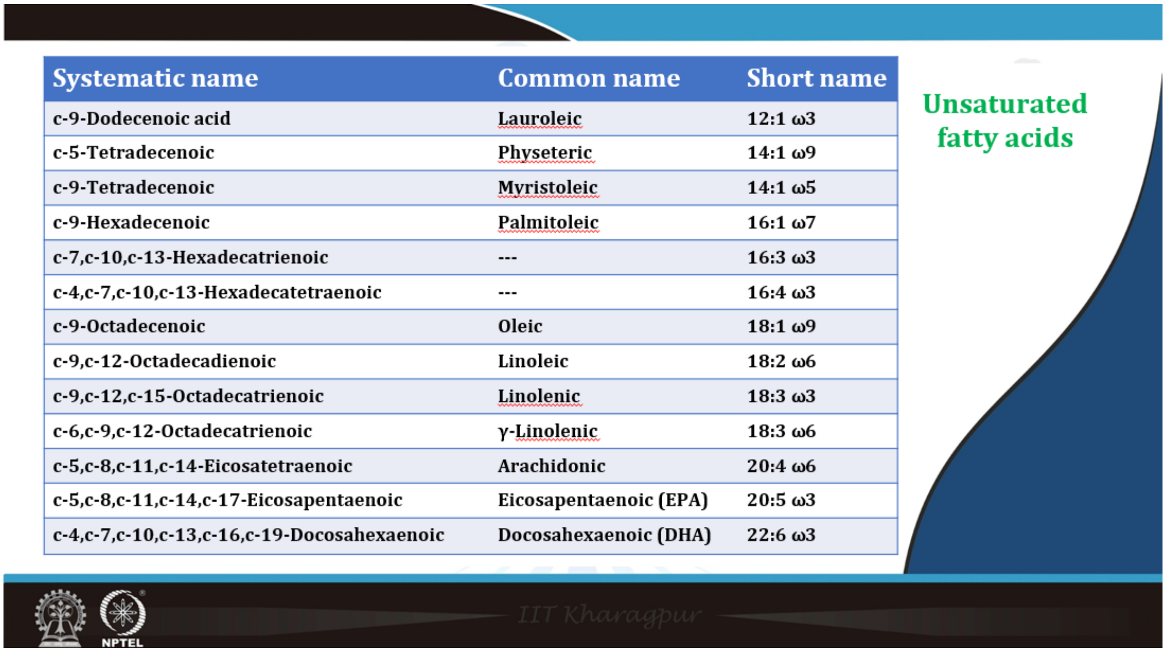


Here you see that is the fatty acids IUPAC nomenclature like 18 1 9 means that there is a 1 carbon atom and that is double bond that is it 1 double bond unsaturation and that is the double bond starts at 9th position from the omega end and that is the same you can write a short hand nomenclature like this or here you see the two hydrogens are on the same side. So, it becomes cis fatty acids. So, normally this short hand that is omega when it is so they are always used for the cis fatty acids only.



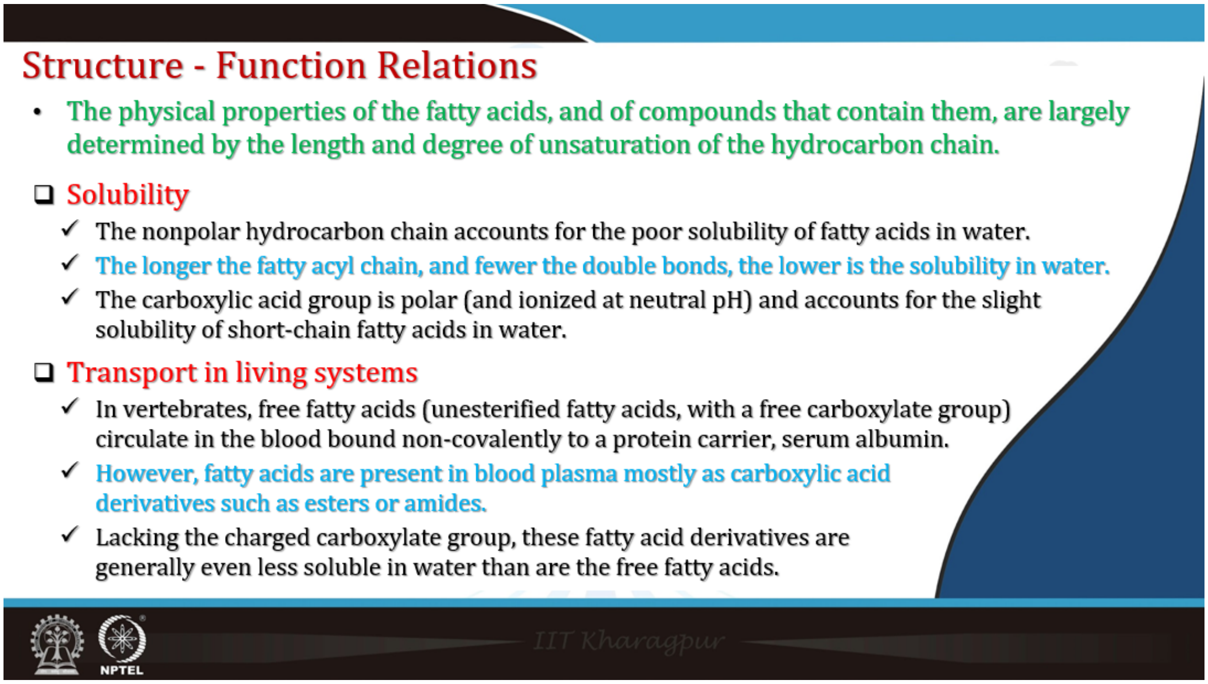
Systematic name	Common name	Short name
Butanoic	Butyric	4:0
Pentanoic	Valeric	5:0
Hexanoic	Caproic	6:0
Octanoic	Caprylic	8:0
Decanoic	Capric	10:0
Dodecanoic	Lauric	12:0
Tetradecanoic	Myristic	14:0
Hexadecanoic	Palmitic	16:0
Octadecanoic	Stearic	18:0
Eicosanoic	Arachidic	20:0
Tetracosanoic	Lignoceric	24:0

So, you see here that is the names of the fatty acid at a glance that is systematic name common name and the short name that is used here like butanoic acid it is known as butyric its short name is 4 colon 0 means there are 4 carbon atoms no double bond that is all these here in this butanoic, pentanoic, hexanoic, octanoic, decanoic, or similarly butyric, valeric, caproic, caprylic, capric, lauric, myristic, palmitic, stearic, arachidic, lignoceric all these are the saturated fatty acids as in the name that is there indicate that there is no double bond and they are having like a lignoceric has 24 carbon atom arachidic has 20 carbon atom in the hydrocarbon chain.



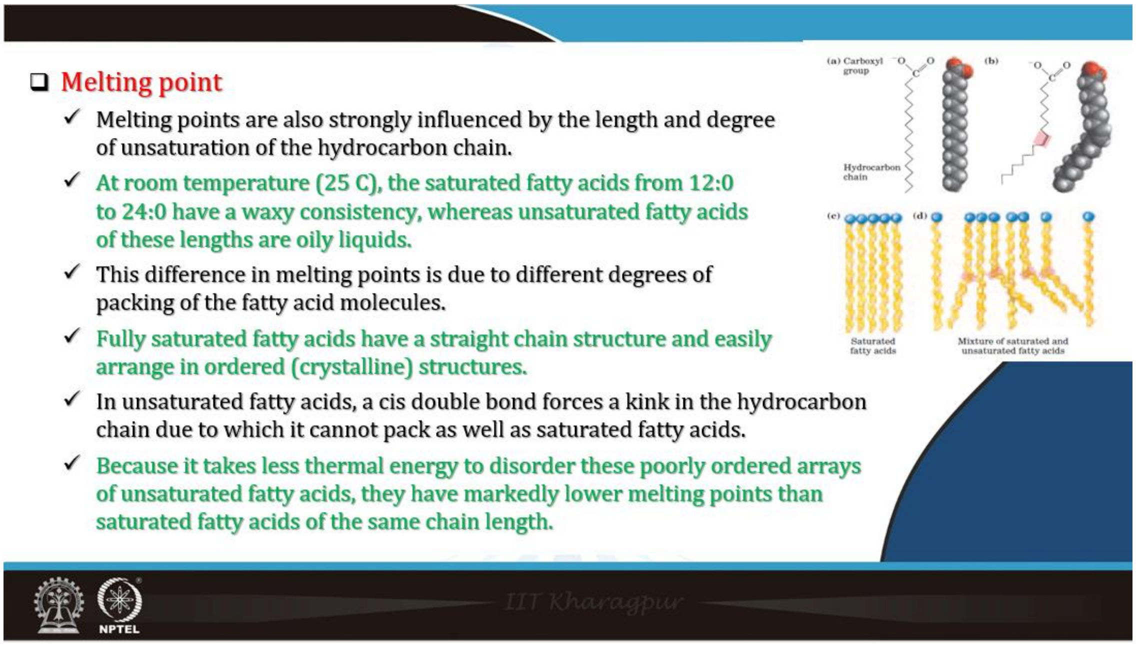
Systematic name	Common name	Short name
c-9-Dodecenoic acid	Lauroleic	12:1 ω3
c-5-Tetradecenoic	Physeteric	14:1 ω9
c-9-Tetradecenoic	Myristoleic	14:1 ω5
c-9-Hexadecenoic	Palmitoleic	16:1 ω7
c-7,c-10,c-13-Hexadecatrienoic	---	16:3 ω3
c-4,c-7,c-10,c-13-Hexadecatetraenoic	---	16:4 ω3
c-9-Octadecenoic	Oleic	18:1 ω9
c-9,c-12-Octadecadienoic	Linoleic	18:2 ω6
c-9,c-12,c-15-Octadecatrienoic	Linolenic	18:3 ω3
c-6,c-9,c-12-Octadecatrienoic	γ-Linolenic	18:3 ω6
c-5,c-8,c-11,c-14-Eicosatetraenoic	Arachidonic	20:4 ω6
c-5,c-8,c-11,c-14,c-17-Eicosapentaenoic	Eicosapentaenoic (EPA)	20:5 ω3
c-4,c-7,c-10,c-13,c-16,c-19-Docosahexaenoic	Docosahexaenoic (DHA)	22:6 ω3

The unsaturated fatty acids similarly you see that some of the common unsaturated fatty acid their systematic IUPAC name, common name, and short name like C9-Dodecenoic acid means it is a 12 carbon containing one double bond at the third position. Then C5 tetradecanoic acid, physeteric acid is 14 one at ninth position then C9 octadecanoic acid that is oleic acid here that is there are 18 carbon one double bond and it is at the ninth position. So similarly in all the names like if there are C5, C6, C7, C8, C11, C14, Eicosa trienoic acid means it is arachidonic acid ok. Eicosa pentaenoic acid that is it has 5 unsaturated bond ok. This is Eicosa tetraenoic acid it will become Eicosa tetraenoic acid it has 4 double bonds ok. So, in this way the names are given to the common name, short name and systematic name of unsaturated fatty acids.



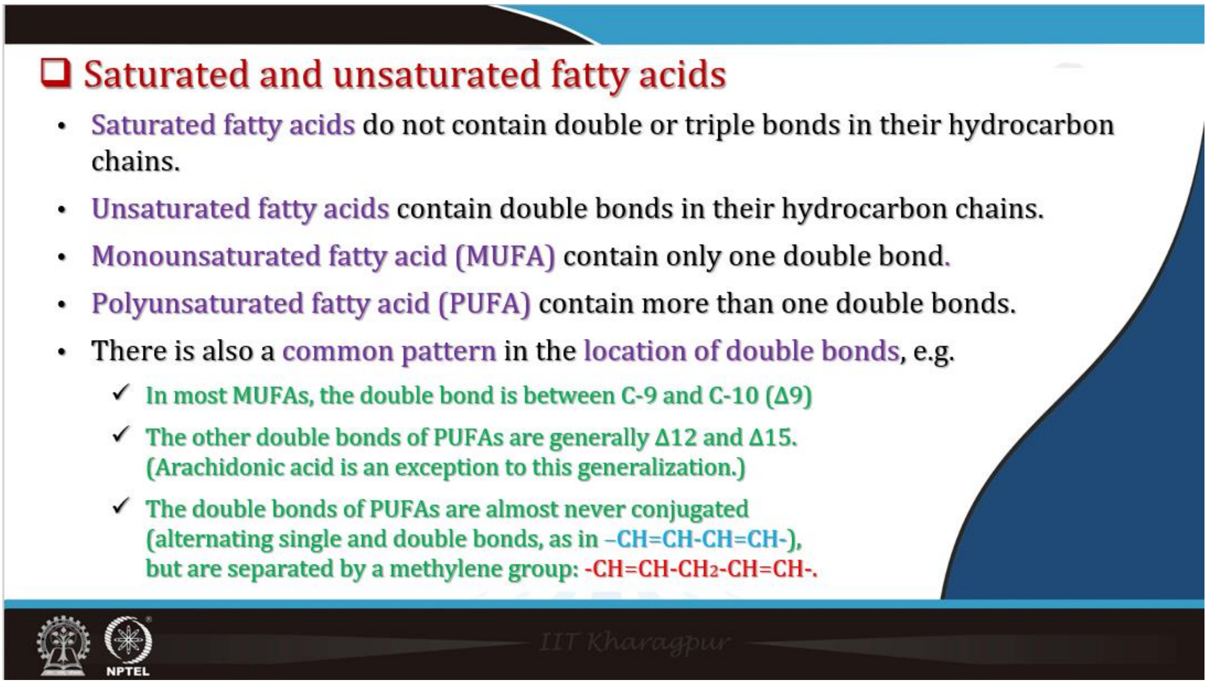
Then let us discuss about a structure function relationships of the fatty acids. The physical properties of fatty acids and of compounds that contain them are largely determined by the length and the degree of unsaturation of the hydrocarbon chain. First and most important property: the solubility. If you look at the nonpolar hydrocarbon chain accounts for the poor solubility of fatty acids in water. The longer the fatty acid chain or fatty acyl chain and fewer the double bond the lower is the solubility in water.

The carboxylic acid group is polar and ionized at neutral pH and accounts for the slight solubility of short chain fatty acid in water. The protein leaving systems the fatty acid if we discuss in vertebrates free fatty acid that is unsterified fatty acids with a free carbogenic group ok. They circulate in the blood bound non covalently to a protein carrier serum albumin. However, fatty acids are present in the blood plasma mostly as carbogenic derivatives such as esters or amides. Taking the charged carboxylate group these fatty acid derivatives are generally even less soluble in water and are the free fatty acids.



The melting points are also strongly influenced by the length and degrees of unsaturation of the hydrocarbon chain ok. More saturated fatty acids, long chain fatty acids higher will be the melting point. More unsaturated fatty acids, short chain fatty acids lower will be the melting point. Even unsaturated fatty acids are liquid at room temperature ok. So, at room temperature the saturated fatty acids from 12 carbon to 24 carbon have a waxy consistency whereas, unsaturated fatty acids of these length are oily liquids.

This difference in melting points is due to the different degrees of packing of the fatty acid molecule. Fully saturated fatty acids have a straight chain structure and easily arranged in order or crystalline structure. In unsaturated fatty acids a cis double bond forces a the hydrocarbon chain due to which it cannot pack as well as the saturated fatty acids. Because it takes less thermal energy to disorder these poorly ordered arrays of unsaturated fatty acids, they have markedly lower melting points than saturated fatty acids of the same chain lengths.

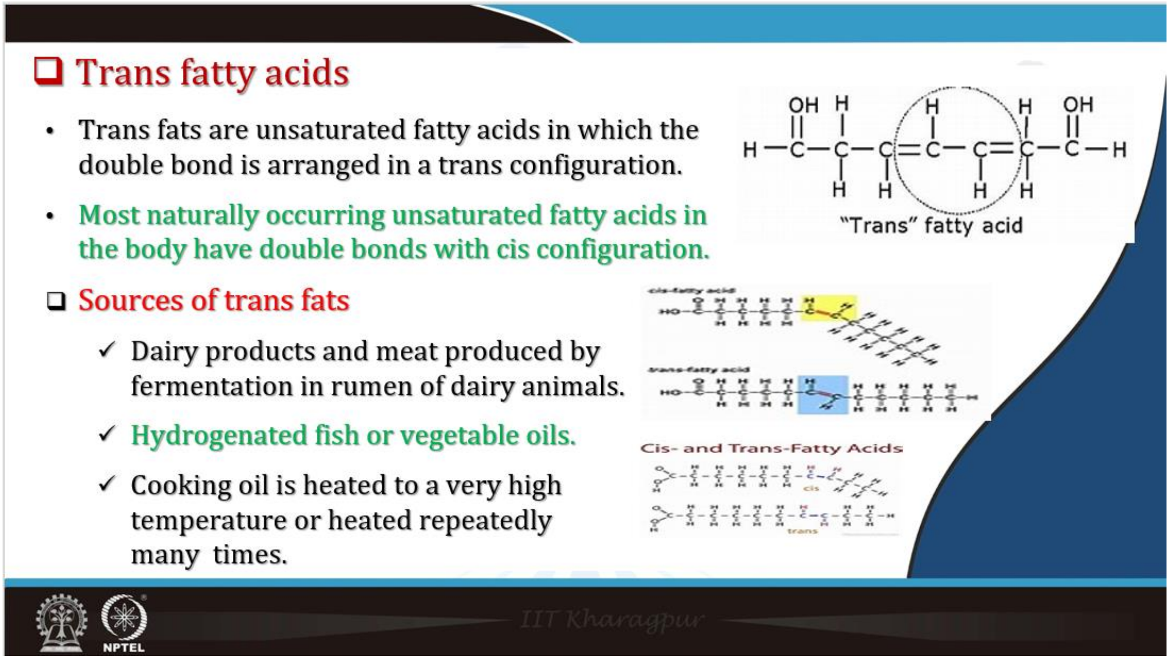


Then saturated and unsaturated fatty acids. We discussed. We have already described little bit of more that is they are obviously, the saturated fatty acid do not contain any double bond. Saturated fatty acids. Unsaturated fatty acids contain one or more double bond. If there is one double bond it is a monounsaturated fatty acid; two or more than two double bond it is called polyunsaturated fatty acids commonly known as PUFA, ok.

There is a there is also a common pattern in the location of double bond. It has been seen in most of the unsaturated fatty acid. Like for example, if it first double bond starts at 5 position then it will be 5, 8, 9, 11 and then 14 and so on. So, there will be some regularity like 9, 12 and then 15 or 6, 9, 12, 6, 9. So, there is a some sort of regularity is a common pattern in found in the positioning of the double bond.

The other double bond of PUFA are generally that is that 12 and 15 that is arachidonic acid ok. However, it is exception to this generalization because it has 5, 8, 11. The double bonds of PUFAs are almost never conjugated like that is it is not like that CH double bond CH and then single CH and double bond CH no you will not find. You will find that in the position 2 that there will be one CH 2 bonds in methyl linkage methylene bridge will be there between one double bond. So, that is why if this here first is 6 then

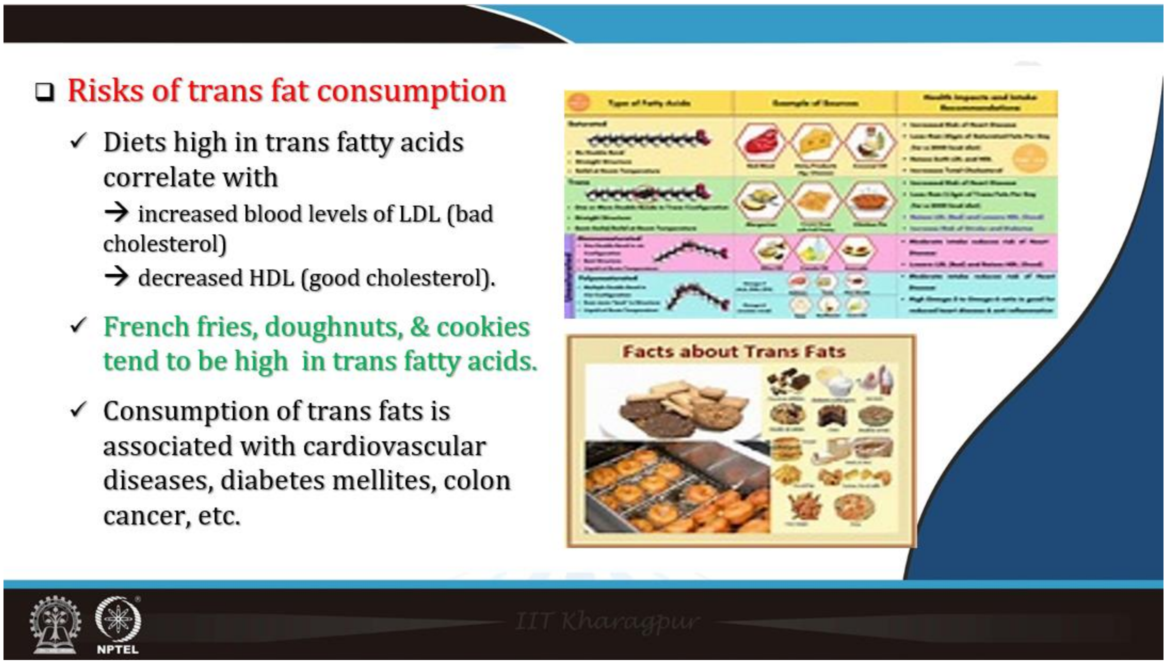
7, 8, 9, if it is 5 then 5, 6, 7, 8. So, there is a difference of the in between there are three carbon atoms alternate it will be there.



Then trans fatty acid I already explained. Further you can see here in the structure here this becomes trans where in the carbon atoms, hydrogen are both are on the opposite side. If the hydrogen atoms on the double bond that is if it is on the same side it becomes cis, like you see here these are on the double side other side. So, they become on the double bond position that is they are on opposite side.

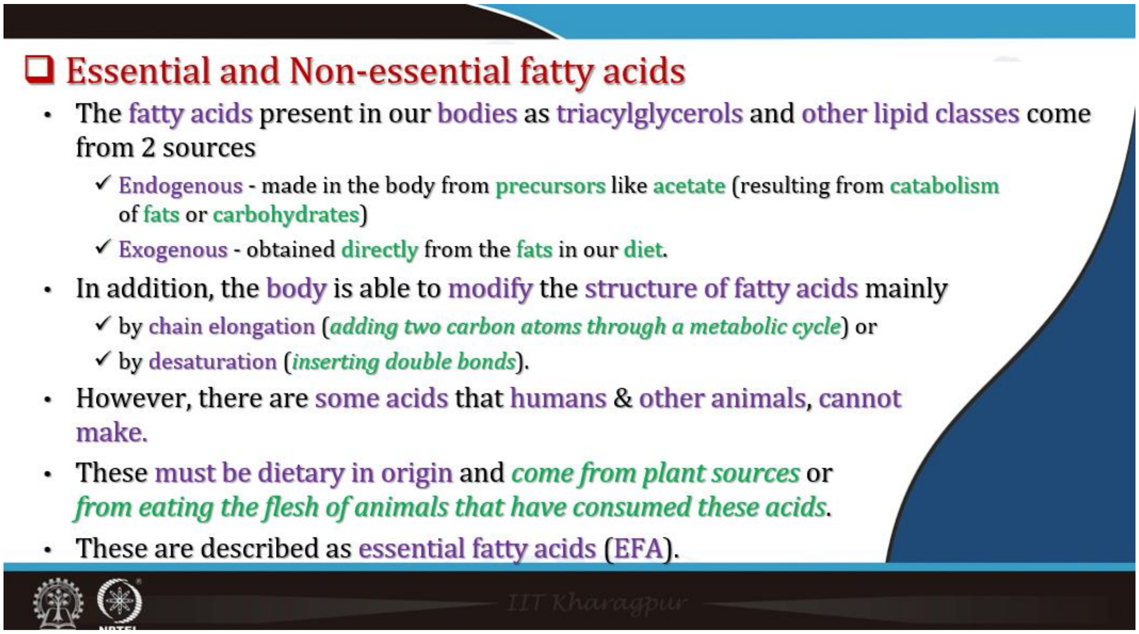
So, it becomes trans. Normally the dairy products and meat product meat produced by fermentation in rumen of dairy animals they contain trans fats also that is hydrogenated fish or vegetable oil.

Generally, they triglycerides when they are in the natural form normally they are in the cis form except for if you in general they are in cis, but when they are heated or processed. So, this during heating that is cooking processes etcetera then this cis is converted into a trans form that is ok.



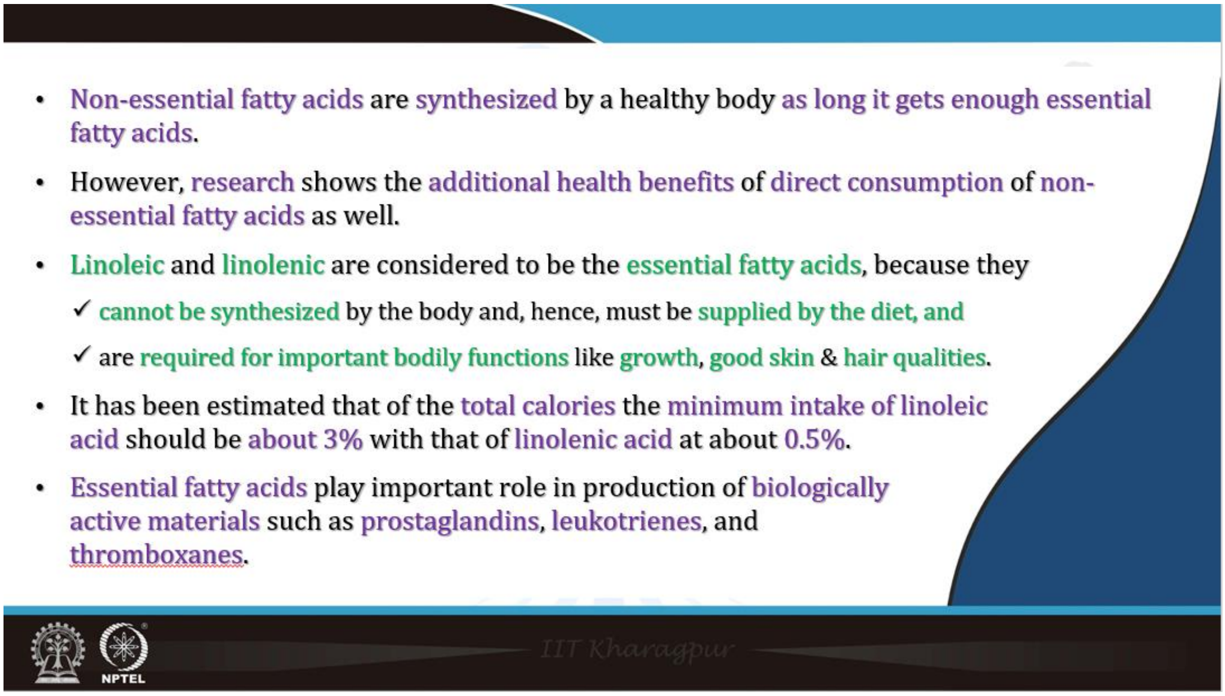
And obviously, this consumption of trans fatty acid always associated with the health hazards ok. Diets high in trans fatty acid correlate with increased blood levels of LDL that blood bad cholesterol as well as decreased level of HDL that is good cholesterol. So, if you take more trans fatty acids it will increase the quantity of bad cholesterol; it will reduce the quantity of good cholesterol.

French fries, doughnuts, cookies etcetera even potato chips and all this they are considered to be having to be more in the trans fatty acids because they are given high heat treatment during heating that is the cis is converted into. So, the consumption of trans fat and I told you is associated with cardiovascular diseases, diabetic mellitus, colon cancer and so on.

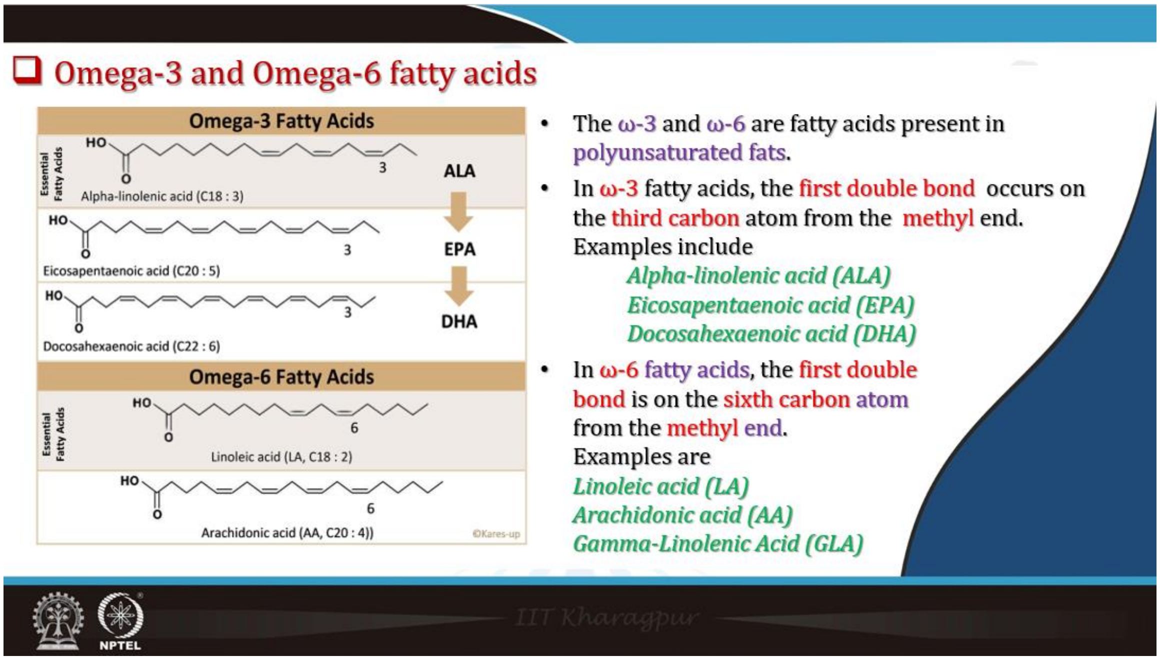


Then comes essential and non-essential fatty acids. These are very important in the earlier class also I discussed about it that is the fatty acids present in our bodies as triglycerides and other lipids classes come from two sources. One is endogenous that is endogenous means that is this is synthesized inside the body. Some fatty acids are synthesized inside our body from the precursor like acetate which are resulting from catabolism of fats or carbohydrates. And then the other source is the exogenous source that is which is obtained directly from the fat in our diet means that is those fatty acids which are not synthesized in our body, but they are important they are necessary for normal functioning of our body or for keeping us in a good healthy conditions. These fatty acids must be taken from the diet and those are taken known as essential fatty acids. Also the body is able to modify the structure of fatty acid mainly by the length elongation that is adding two carbon atoms through a metabolic cycle or by desaturation that is inserting double bonds in it. But there are certain acids that humans and other animals cannot make or even they cannot desaturate like the plant they can desaturate steric into oleic, oleic into linoleic and linoleic into linolenic.

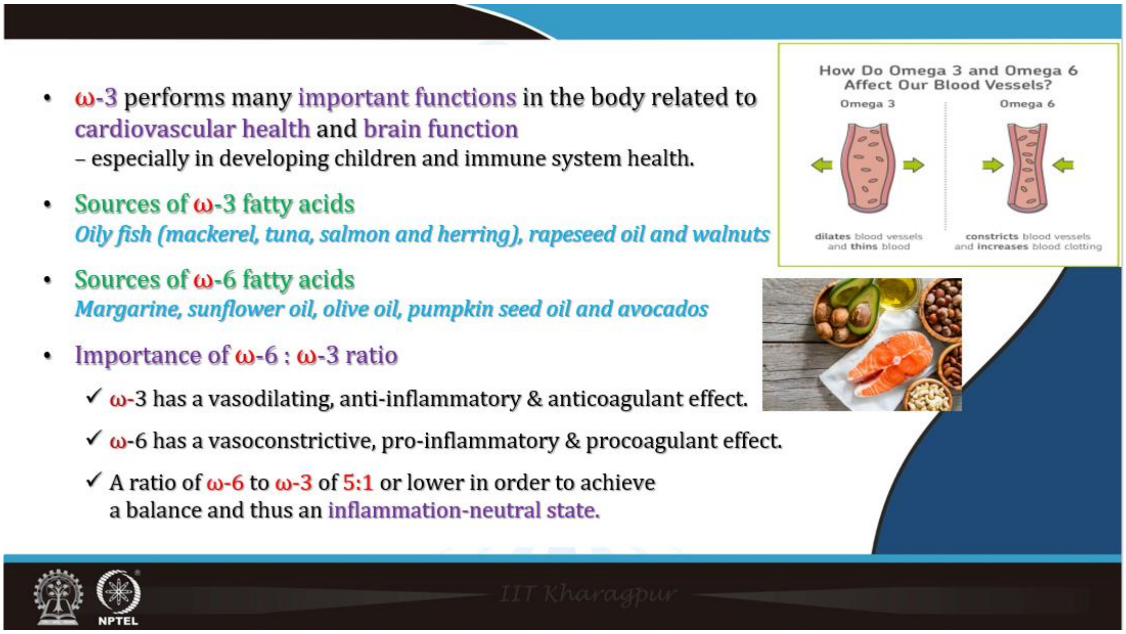
But our system animal human system cannot desaturate linoleic into linolenic or oleic into linoleic. So these, but at the same time these are very very important for our healthy life healthy living. So, they must be consumed through food and they are described as essential fatty acids that is they are essential for our body.



So, non-essential fatty acids are synthesized by a healthy body as long as it gets enough essential fatty acids. However, research shows that additional health benefits of direct consumption of non-essential fatty acids as well linolenic as well as linoleic are considered to be the essential fatty acid because they cannot be synthesized by our body hence must be supplied by the diet and they are required for important bodily functions like growth, good skin, air quality etcetera. So, it has been estimated that the total calories the minimum intake of linoleic acids should be around 3 percent with that of linolenic acid at about 0.5 percent. Non-essential fatty acids play important role in the production of biologically active material such as prostaglandins, leukotrienes and thromboxanes.



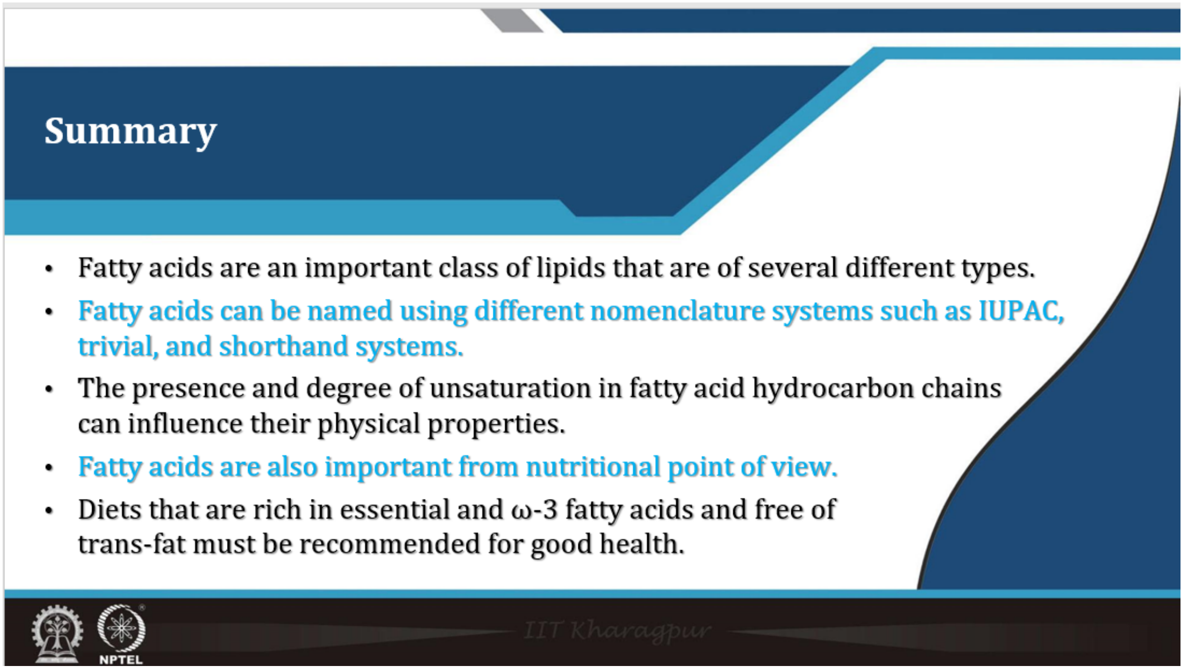
The here see that the some of the omega 3 and omega 6 fatty acids that is omega 3 and omega 6 fatty acids are present in the polyunsaturated fats in omega 3. The fatty acid as I told you earlier also the fatty acid first double bond occurs on the third carbon as you can see here third carbon of the from the methylene. For example, alpha linolenic acid, eucosa pentanoic acid or docosa hexanoic acid in all these that is the this is the methylene and the first double bond starts at third position third carbon atom. Similarly, in the omega 6 fatty acid the first double bond is on the sixth carbon atom from the methyl end like linoleic acid, arachidonic acid, gamma linoleic acid and so on. Also there are that omega 9 fatty acids similarly they are named.



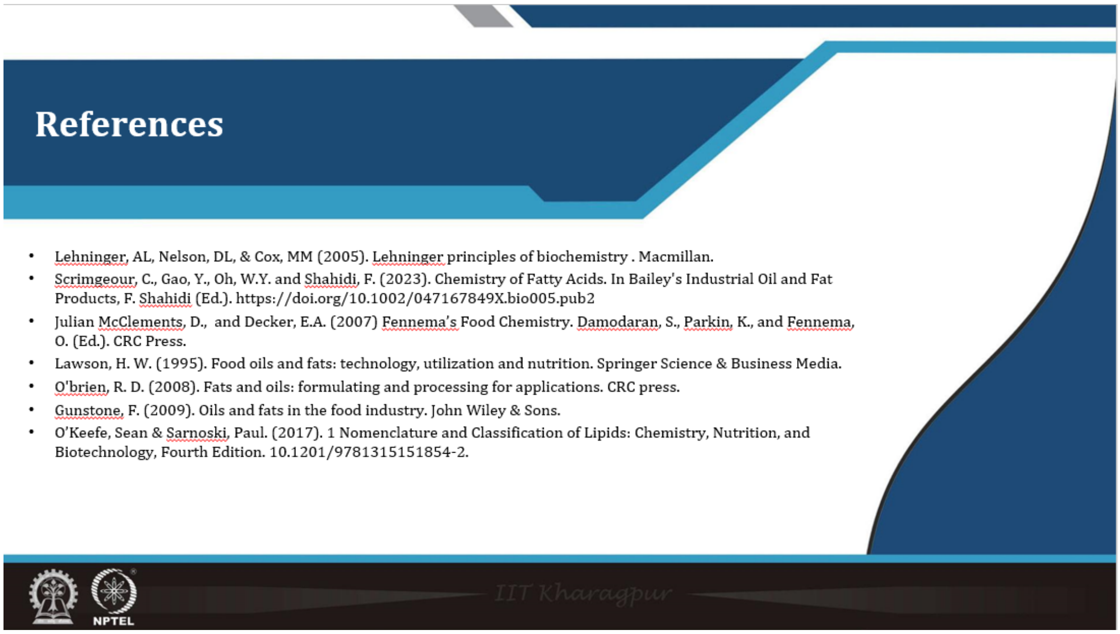
Omega 3 performs many transport functions in the body related to the cardiovascular health and brain function especially in developing the children and immune system health. Sources of omega 3 fatty acids: generally major sources include oily fish like mackerel, tuna, salmon or herring, even rapeseed oil and walnuts they also contain good amount.

Then sources of omega 6 fatty acid include margarine, sunflower oil, olive oil, pumpkin, seed oil, avocado etcetera. So, if you look at the important of omega 6 and omega 3 very very important and particular ratio of the omega 6 to omega 3 is very important from for normal functioning of our body. Omega 3 has a vasodilating vasodilating and anti inflammatory and anti-coagulant effect ok whereas, omega 6 has a vasoconstrictive, pro-inflammatory and pro-coagulant effect. See that omega 3 it dilates the blood vessel whereas, omega 6 it constricts the blood vessels. So, when the blood vessels are constricted it increases the blood clotting ok.

When the blood vessels are dilated then obviously, it will thin it cause the thinning of the blood. So, this is very important. So, a proper ratio of omega 6 to omega 3 of 5 is to 1 or lower is necessary in order to achieve a balance and thus an inflammation neutral state.



So, I would like to summarize this to the lecture that fatty acids are an important class of lipids that are of several types. Fatty acids can be named using different nomenclature systems such as IUPAC, trivial name, short hand systems for naming in which short names are provided to the fatty acid. Then the presence and degree of unsaturation in fatty acids and hydrocarbon chain can influence their physical properties almost all even biological properties, functional properties that is the number of unsaturated linkage, positioning of these linkages, chain length, degree of unsaturation all these will influence the properties of the fats and oil and their other characters even the free fatty acids if there is a more it will also influence processing characteristics and other. Fatty acids are also important from nutritional point of view that only you diets that are rich in essential and omega 3 fatty acids and free from trans fat must be recommended for a good health.



So, these are some of the references which has been cited in this lecture.

Thank you very much for your patience here. Thank you.